

EDN

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS

- SPECIAL ISSUE:
Test and measurement
- μ Cs turn handheld DMMs
into capable R&D tools
- Software bugs yield to
emulator, bus-state analyzer
- ADEE East '86 preview

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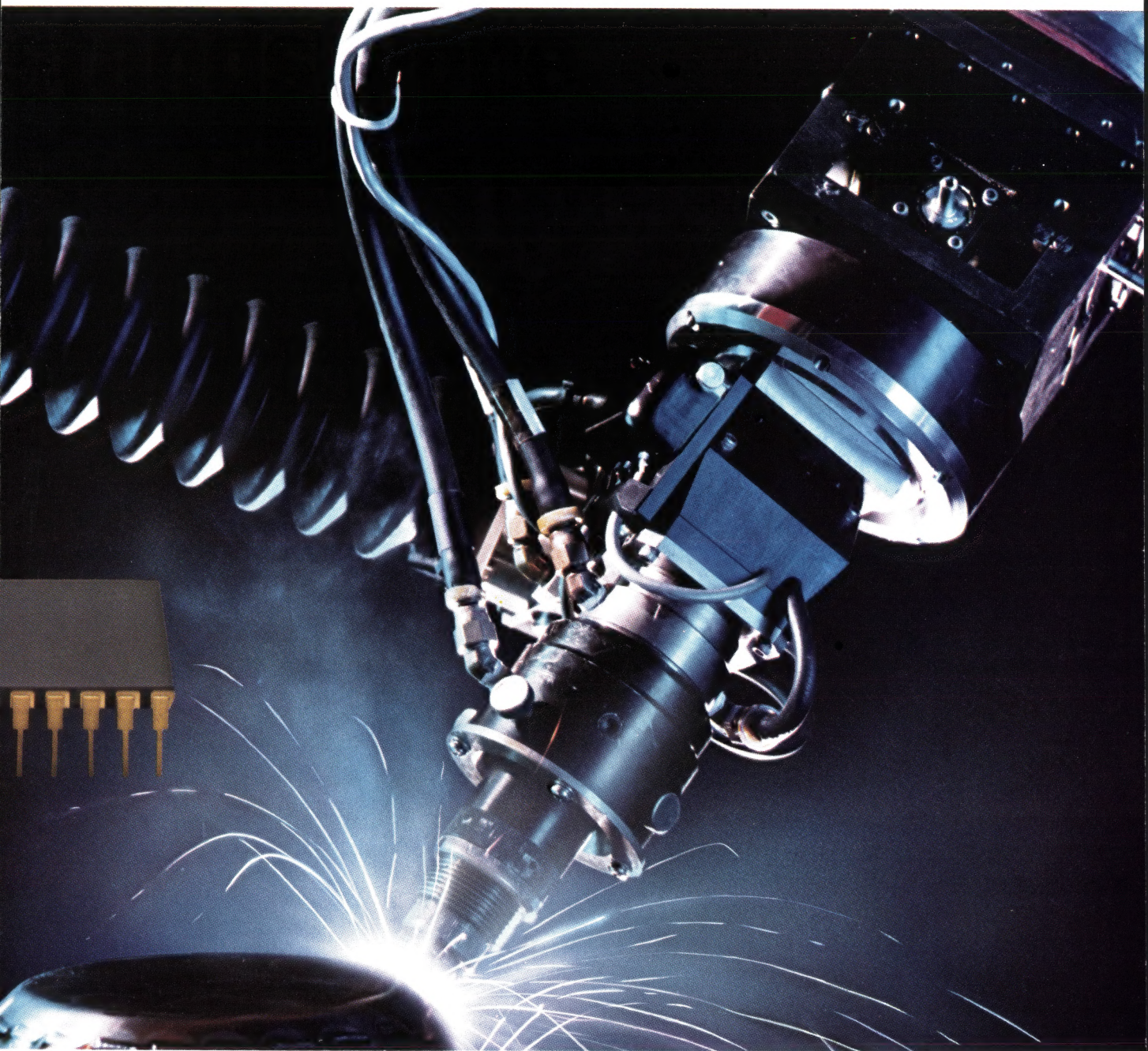
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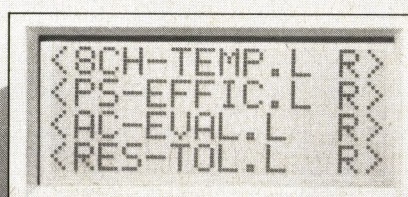
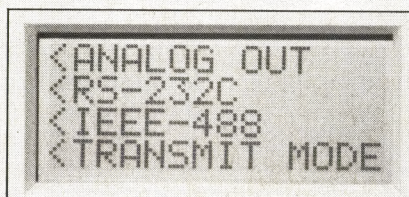
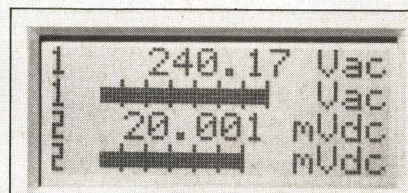
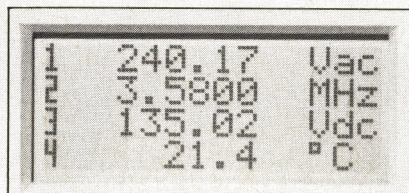
Model 52 is also a data logger. Add optional multiplexers and you can gather up to 252 channels of analog data and store the readings in nearly a megabyte of RAM. Digital I/O options add up to 32 bits of digital input and output as well as D/A capability for external control applications.

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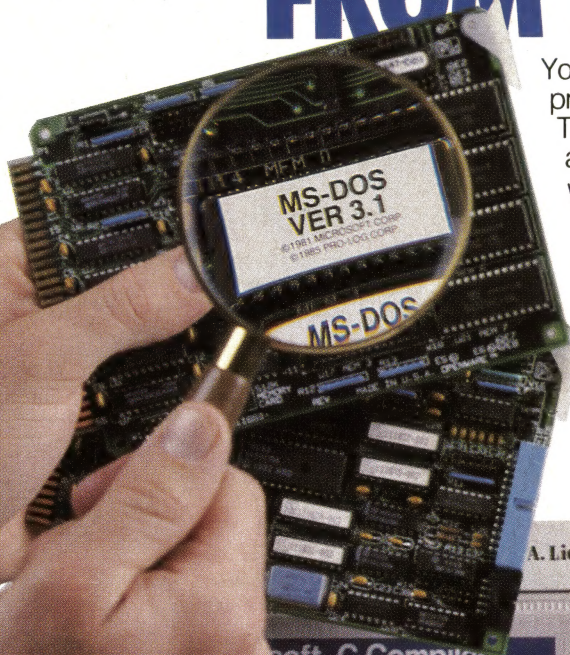
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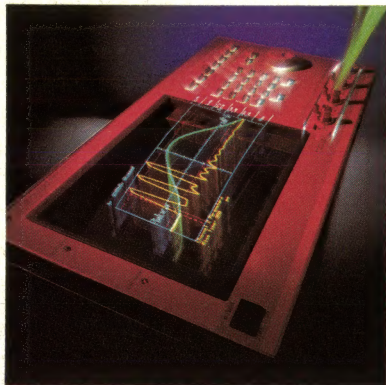


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On the cover: Capturing signals that have subnanosecond rise times is no problem for high-performance oscilloscopes. Moreover, such scopes are including features like color displays and differential-measurement and XY-plotting capabilities. See pg 134. (Photo by Reg Francklyn, art direction by Steve Galchutt; photo courtesy Hewlett-Packard)

SPECIAL ISSUE: TEST AND MEASUREMENT DESIGN FEATURES

Special Report: High-performance oscilloscopes 134

This year, more high-performance oscilloscopes than ever are available in the 150-MHz to 1-GHz bandwidth range. Unlike earlier high-performance scopes, many recent models offer extra features—such as onscreen cursors, LCD readouts, and automatic setup capabilities—that both make the instruments easier to use and improve their productivity.—*Chris Everett, Regional Editor*

Word generators bring order to logic testing 159

Logic analysis no longer entails just using a logic analyzer. A logic analyzer isn't a comprehensive solution to logic testing. Given the complexity of today's circuitry, you have to complement an analyzer with a word generator if you want to systematically test logic circuits.—*Robert Delp and Peter Kleindienst, Dolch Logic Instruments*

Test hardware helps pinpoint software bugs 169

Setting breakpoints through the use of software debugging tools can solve some of your problems, but other bugs are more difficult to isolate and fix. Your chances of doing so improve considerably when you add an in-circuit emulator and a bus-state analyzer to your debugging arsenal.—*Thomas R Blakeslee and John S James, Orion Instruments*

Fault simulation rates effectiveness of test patterns 181

You can use several fault-simulation techniques to evaluate how effectively a set of test vectors will uncover manufacturing defects in your circuit designs. Fault-simulation programs can help you produce the exact set of test vectors you need for a given level of fault coverage.—*Geoffrey Indrajio and Laung-Terng Wang, Daisy Systems Corp*

Current-mirror FETs cut costs and sensing losses 193

Power MOSFETs that set aside a portion of their source cells for current-sensing purposes allow you to monitor the FETs' total drain current without the need to insert high-power, loss-producing resistors in series with the load current. To use these devices most effectively, you should understand the sensing current's behavior.—*Gary Fay, Motorola Semiconductor Products*

Continued on page 7

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CIRCLE NO 76



Manufacturers are extending the basic flat-panel-display technologies—liquid crystal, vacuum fluorescence, electroluminescence, and gas discharge—to produce low-cost and highly readable screens for industrial, military, and portable applications (pg 79).

TECHNOLOGY UPDATE

Increased scale lengths, math functions make handheld DMMs general-purpose R&D tools 61

Thanks to single-chip- μ C control, handheld digital multimeters now offer measurement performance and features that were formerly found only on benchtop instruments.—*Peter Harold, European Editor*

Advances in flat-panel-display technology improve display features and cut prices 79

The R&D dollars that flat-panel-display manufacturers have spent over the past two years are finally bearing fruit: Prices are falling, the displays are more readable thanks to higher resolution and sharper contrast, and a few color displays are now available.—*J D Mosley, Regional Editor*

ADEE East '86 sessions, courses, workshops stress practical CAD/CAE applications 93

This year's Automated Design and Engineering for Electronics conference—ADEE East '86—takes place at the World Trade Center on Commonwealth Pier in Boston from September 30 through October 2 and emphasizes the practical aspects of today's CAE and CAD systems.—*Steven H Leibson, Regional Editor*

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PRODUCT UPDATE

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Latch array provides bank of control words 207

Multiplexers expand 8051's data/code space 208

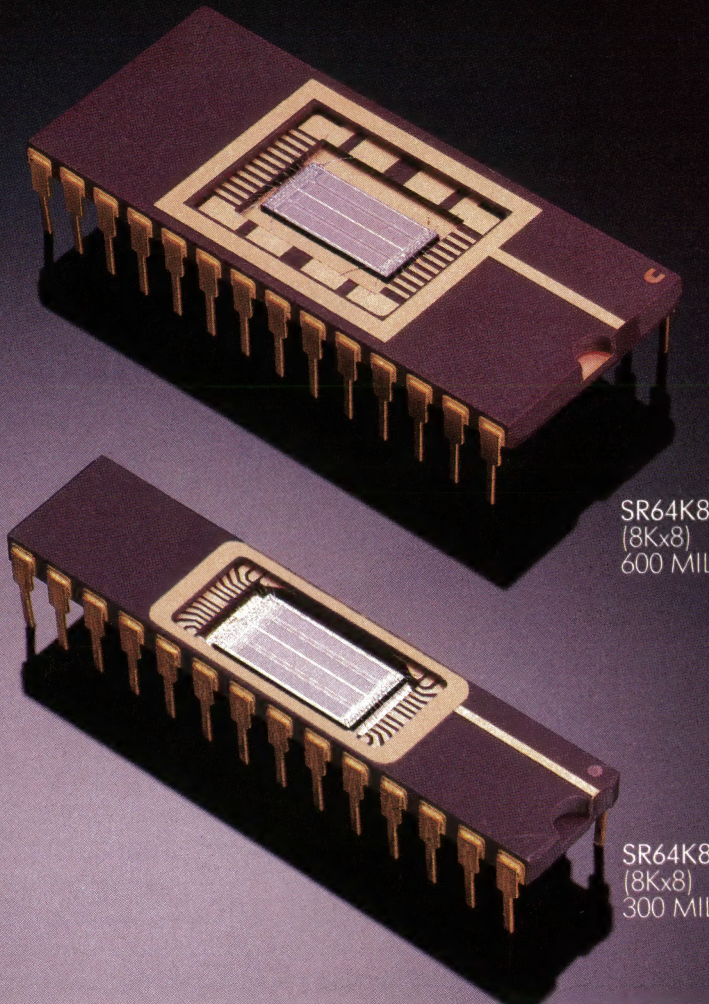
AGC circuit uses an analog multiplier 210

IC emulates many types of logic gates 212

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F Warren Dickson

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Roy Forsberg

Editor
Gary Legg

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Assistant Managing Editor
Joan Morrow

Home Office Editorial Staff
275 Washington St, Newton, MA 02158
(617) 964-3030

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Peter Harold, *European Editor*
0603-630782
(St Francis House, Queens Rd,
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Some software developers unwisely refuse the benefits of computer-aided software engineering. They think, incorrectly, that CASE tools diminish creativity.

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Remember to vote in the IEEE election.—*Deborah Asbrand, Staff Editor*

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μ P technology gives boost to chart recorder sales . . . Sales of discrete semis to reach \$9.83B by 1990.

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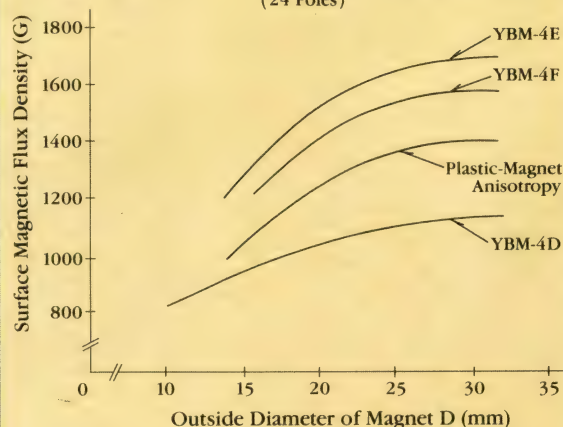
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(BH) max. (MG·Oe)	17	22	26

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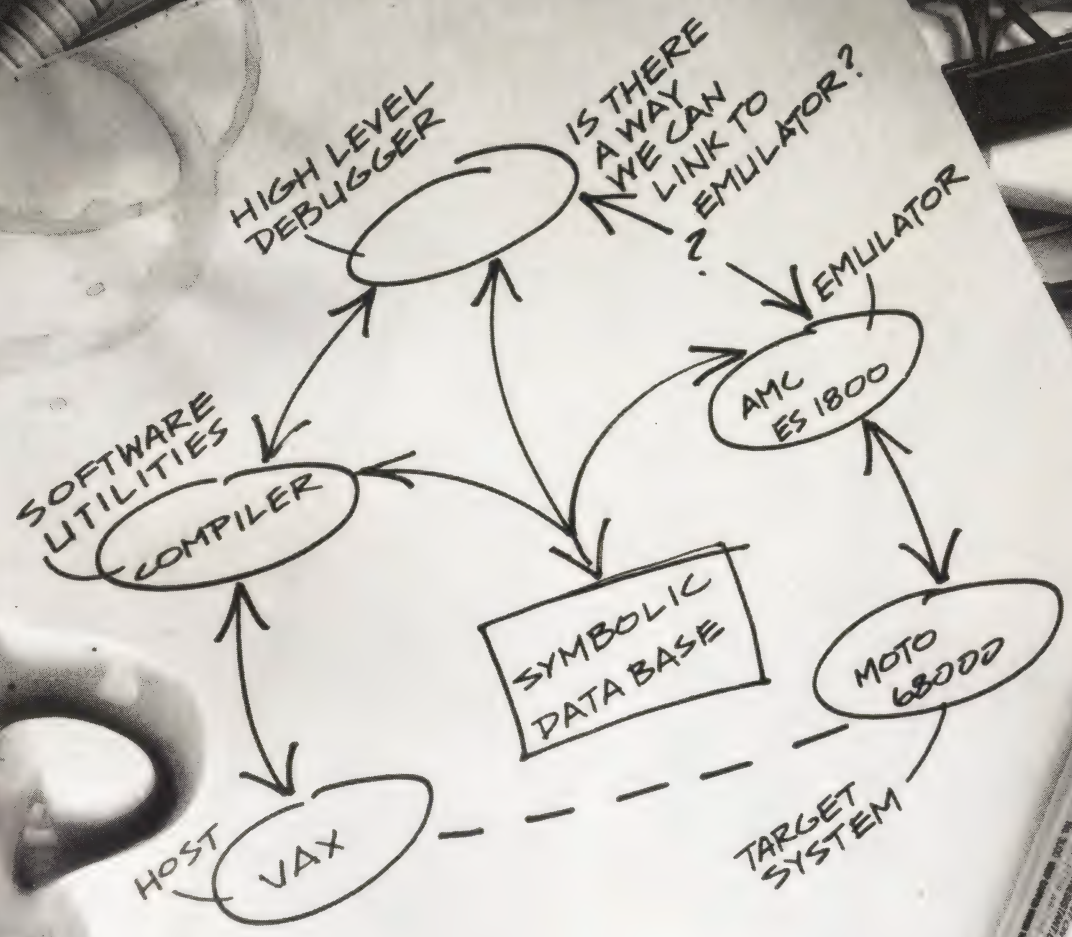
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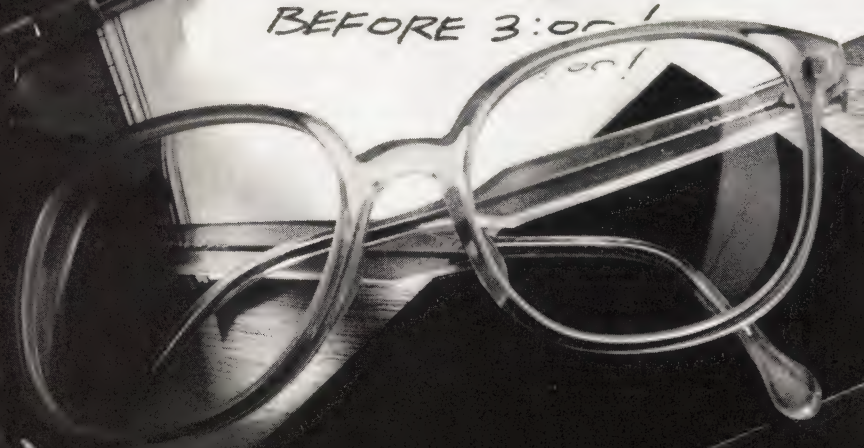


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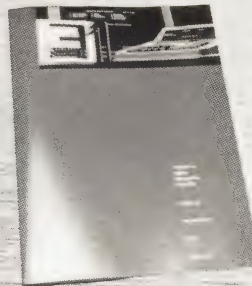
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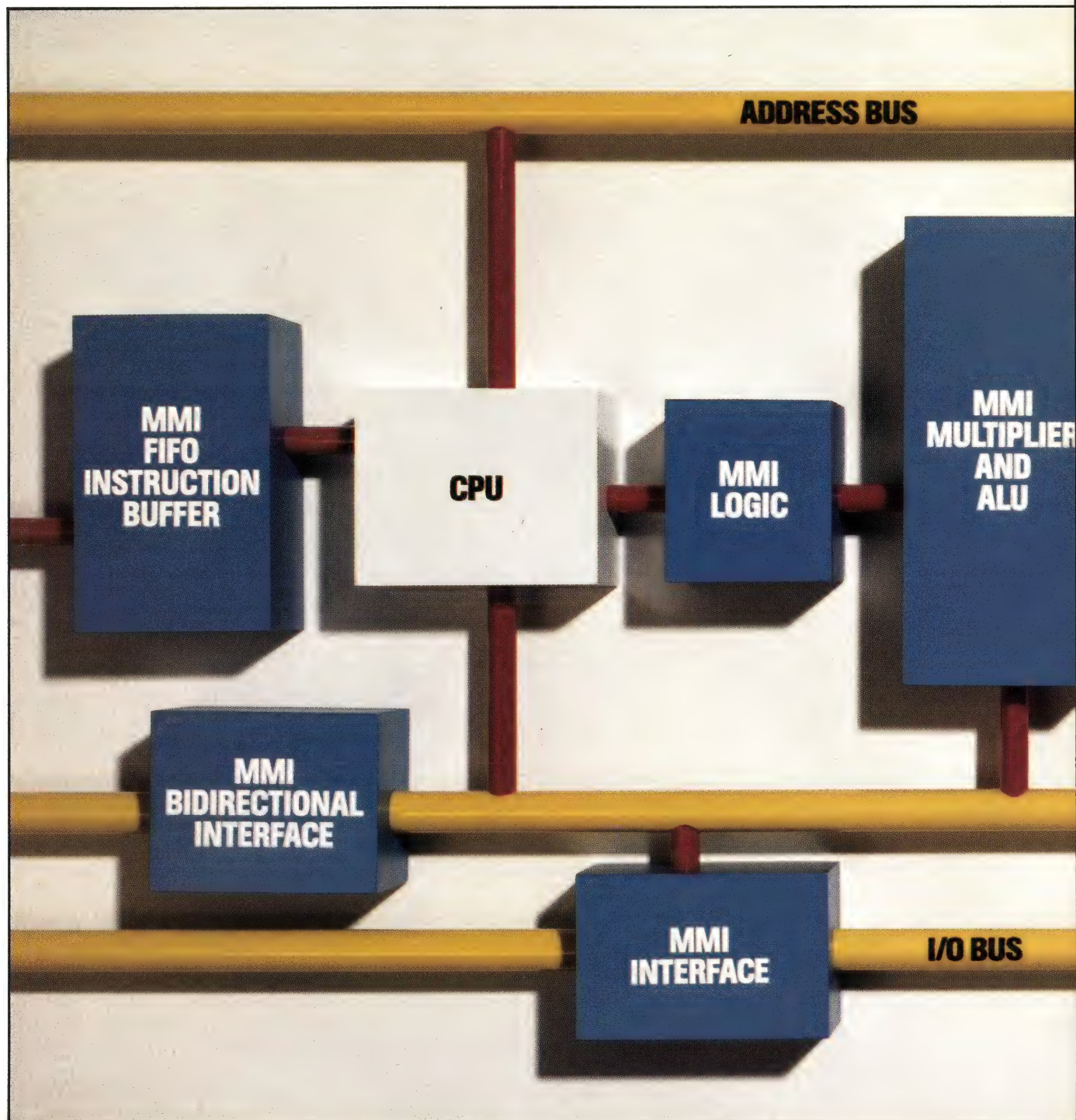
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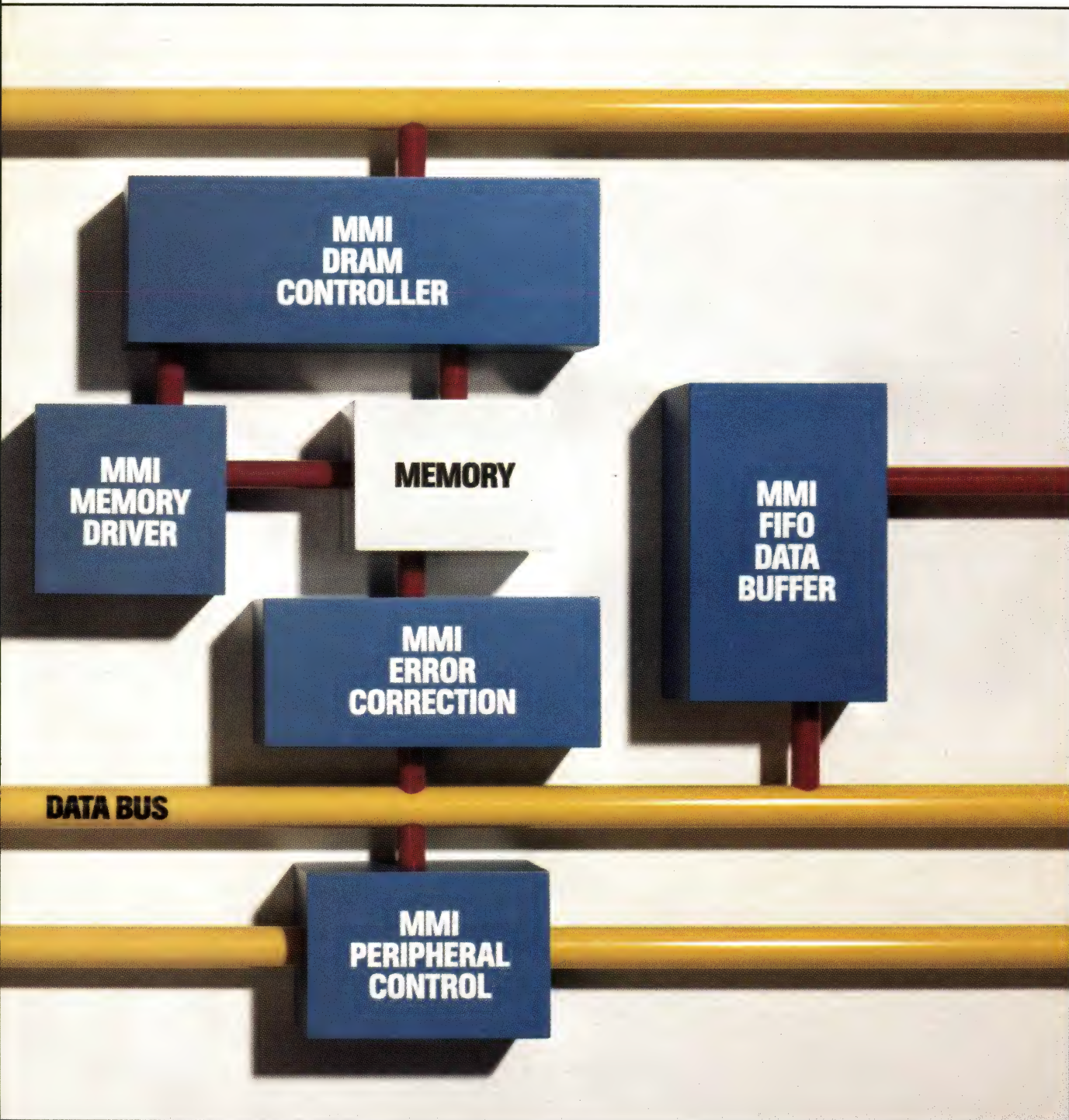
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CIRCLE NO 196



NEWS BREAKS

EDITED BY GEORGE STUBBS

PLDs BOOST SPEED TO 15 nSEC, CUT POWER

Texas Instruments (Dallas, TX, (800) 232-3200, ext 700) has introduced a family of four 24-pin programmable logic devices, each of which specs a maximum propagation delay of 15 nsec (10 nsec typ)—a 40% improvement over the devices' 25-nsec counterparts. Functionally equivalent to and pin compatible with the company's slower devices, the 15-nsec TIBPAL20 PLDs also require 30 mA less current, yielding a 180-mA max I_{cc} . Operating from 5V over 0 to 70°C, these ICs come in plastic DIPs at a cost of \$6.50 (1000).—J D Mosley

8-MHz 80286-BASED MOTHER BOARD REPLACES PC/XT VERSION

You can increase the speed and power of your IBM PC/XT by replacing the mother board with the Tiger-286 from Computer Peripherals Inc (Newbury Park, CA, (805) 499-5751). A PC/XT with the 8-slot mother board achieves a 9.2 Norton Utilities speed rating (a standard PC/XT rates a 1). The board includes an 8-MHz 80286 processor and 1M byte of RAM. The system memory uses 640k bytes; 348k bytes serve as buffer memory for the hard disk, reducing the disk-interleave factor from 6:1 to 2:1. The board has the same dimensions and mounting holes as the PC/XT and draws 2A at 5V. \$1295.—Margery S Conner

LOW-COST AUTOROUTER JOINS PC-BASED CAD PACKAGE

A \$975 autorouter option for Visionics's (Sunnyvale, CA, (408) 745-1551) EE Designer pc-board CAD package, which is for the IBM PC and compatible computers, routes signals automatically on boards as large as 24×24 in. The option routes 2-sided boards or two signal layers of a multilayer board (you add additional layers for power and ground manually). The company plans to ship a free multilayer autorouter to purchasers later this year. You can instruct the router to automatically route all traces on your board or interactively route on a net-by-net or pin-to-pin basis. The router supports a 50-mil grid, 13-mil signal-trace and 50-mil power-trace widths, and maximum component-pad and via diameters of 62 and 55 mils, respectively. You need EE Designer version 1.2 or later and 640k bytes to run the autorouter.—Steven H Leibson

SOFTWARE KIT PROTECTS PROGRAMS FROM PIRACY

A software authorization kit from Dallas Semiconductor (Dallas, TX, (214) 450-0431) lets a software writer, publisher, or value-added reseller lock application programs. You can perform the operation in less than four hours, even if you have minimal programming skills. The kit—the DS1253C—consists of an IBM PC-compatible floppy disk with tutorial examples for locking C, Fortran, Basic, and Pascal programs. The kit's Keyring plugs into the PC's parallel port, and an Electronic Key plugs into the Keyring. By following the examples provided on disk, the user programs the Electronic Key with critical information from an application program, so that without the key, the program won't run. Copies of the master Electronic Key can be made with one keystroke. The kit costs \$60, and additional Electronic Keys sell for \$7; extra Keyrings cost \$22.25 (100).—J D Mosley

TAPE AUTOMATED BONDING NOW AVAILABLE FOR SMD CHIPS

You can now gain the high yield and rapid throughput of tape-automated-bonding (TAB) technology for your surface-mount devices with the TAB lead-frame tape from 3M (Austin, TX, (512) 834-6680). The tape is 8 mils thick at the outer leads for rigid attachment at the board level, but the inner leads are 2 mils thick to accommodate at-

NEWS BREAKS

tachment to the thinner die leads. The company's photolithographic process facilitates tooling, and you can select from a number of plating metals for the copper leads. Prices depend upon your lead count and application.—J D Mosley

IC PROVIDES FAST, 12-BIT, 4-CHANNEL T/H FUNCTION

The CSC31412 is a monolithic track/hold IC from Crystal Semiconductor (Austin, TX, (512) 445-7222). It furnishes a 1- μ sec acquisition time with 0.5-nsec aperture jitter. Suitable for use as the front end for an A/D converter, the CSC31412 includes four T/H amplifiers with 12-bit accuracy, on-chip hold capacitors, an output multiplexer, two output buffer amplifiers, and a μ P interface. This chip offers a 700- μ V total unadjusted error to within $\frac{1}{2}$ LSB. The CSC31412 costs \$50 (100).—J D Mosley

80386 BOARD FOR PC/XTs, PC/ATs SPEEDS LISP DEVELOPMENT

The 386 HummingBoard from Gold Hill Computers (Cambridge, MA, (617) 492-2071) is an 80386-based board that plugs into any IBM PC/XT, PC/AT, or compatible computer to offer artificial-intelligence application developers the performance of a dedicated Lisp workstation. The board comes with the Gold Common Lisp 386 development-system software for \$1195. The software/hardware combination lets you address as much as 15M bytes of memory, and it includes a large memory interpreter and compiler, editor, tutorial, and on-line help system. Running five times faster than the company's 286 Lisp Developer, the new system supports lexical scoping, Lisp packages, and transcendental functions. Shipments are scheduled to start in the fourth quarter.—J D Mosley

HARRIS UNVEILS GaAs HYBRID MONOLITHIC MICROWAVE ICs

Operating in the 6- to 18-GHz band, the HMM-11810-0 GaAs monolithic microwave IC amplifier from Harris Microwave Semiconductor (Milpitas, CA, (408) 262-2222) is supplied in die form for hybrid-circuit applications requiring 5 dB of small-signal amplification. Fabricated with the company's 0.5- μ m GaAs process, the part features on-chip dc-blocking capacitors to reduce hybrid-circuit fabrication costs, simplify designs, increase reliability, and maintain typical supply currents at 125 mA. Delivery time for the HMM-11810-0 is six weeks ARO; it costs \$195 (100).—Denny Cormier

KIT EASES DESIGN OF BIT-MAPPED GRAPHICS SYSTEMS

If you design bit-mapped graphics systems, you might be interested in the \$99 TMS340GDK graphics design kit from Texas Instruments (Dallas, TX, (800) 232-3200, ext 700). This kit includes a video system controller, a color-palette IC, a 64k $\times$ 4-bit video RAM in a leaded SIP, a 4-bit bidirectional universal shift register, and a 68-pin plastic leaded chip carrier socket for the video system controller. The kit also includes user guides, data sheets, and application notes.—J D Mosley

NONMULTIPLEXED LCD DRIVER INCREASES DISPLAY LEGIBILITY

Because the MC145453 LCD driver from Motorola (Austin, TX, (512) 928-6880) doesn't require you to multiplex its 33 segment-driver outputs, your displays will produce wider viewing angles and higher contrast for increased legibility. This CMOS IC consists of a 36-stage shift register, 33 latches, and output buffers that can drive as many as 33 LCD segments or dots. Segment drive current is 20 μ A; operating voltage can vary from 3 to 10V. The IC operates over -40 to +85°C. The MC145453 is available either in a plastic DIP for \$3.57 or in a plastic leaded chip carrier package for \$4.64 (500).—J D Mosley

TRW LSI now offers you a second source for the Weitek WTL1032/1033... at a lower price!

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NEWS BREAKS: INTERNATIONAL

BY PETER HAROLD

VME BACKPLANES OVERCOME BUS-BUSY SIGNAL GLITCHES

Enhancements to the VME Bus J1 backplanes manufactured by BICC-Vero Electronics Ltd (Southampton, UK, TLX 477984) prevent glitches from appearing on the bus-busy (BBSY*) signal line. The glitches, noted by several system integrators who use conventional VME Bus backplanes in large systems, result from crosstalk between the data-transfer-bus (DTB) line and the bus-busy line. If this crosstalk coincides with a local shift in ground-plane voltage at the bus-busy line driver, the combined effect can cause the bus-busy signal to cross a TTL threshold at its receiver end, in turn causing premature release and reallocation of the DTB line.

To overcome this problem, BICC-Vero has rerouted the bus-busy signal, effectively burying it in the backplane's ground plane. Additional enhancements to the backplanes include the provision for alternative power connectors, additional power-rail decoupling, and onboard termination networks. Prices for the new backplanes range from £45.10 for a 2-slot backplane to £388.48 for a 21-slot version.

DSO MATCHES 100-MHz ANALOG SCOPE PERFORMANCE

The Model 4070 digital storage oscilloscope (DSO) from Gould Electronics' Instrument Systems Div (Hainault, UK, TLX 263785) features 400M-sample/sec, 8-bit digitizers and 1k-sample memories for each input channel, allowing it to capture transient or repetitive signals that have a bandwidth as high as 100 MHz. Selectable linear or sine interpolation allows you to optimize the DSO for examining square-pulse or sine-related input signals. The DSO has main and delayed timebases; you set delayed timebase control by time or by number of events.

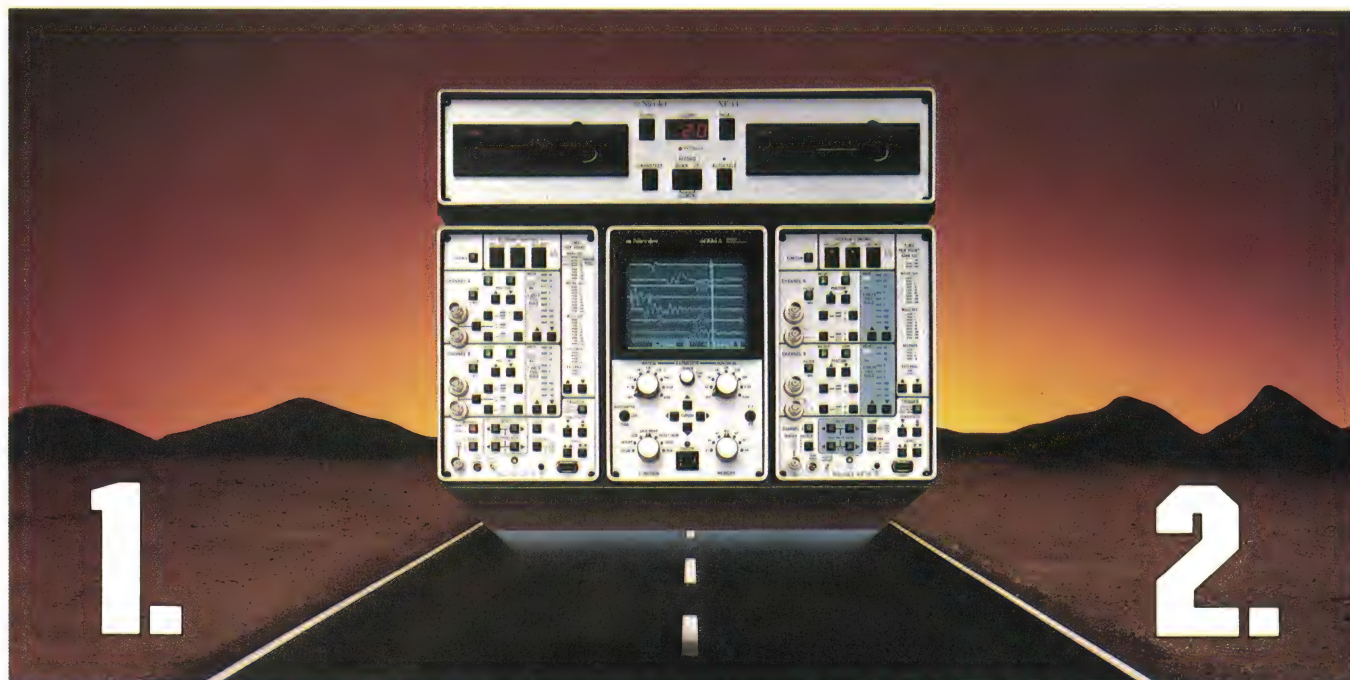
An optional remote keypad allows you to control signal capture or to perform poststorage processing, including waveform analysis and measurement functions. An integral 4-color plotter produces fully annotated waveform plots. For ATE applications, you can remotely control the scope and interrogate measurements via IEEE-488 and RS-423 interfaces. A 2-channel version of the scope, priced at £7750, is available. A 4-channel version, priced at approximately £9500, is scheduled for release in the first quarter of 1987.

CVSD CODECS ENABLE VOICE COMMUNICATION AND STORAGE

Two continuously variable slope delta-modulation (CVSD) codecs from Consumer Microcircuits Ltd (Witham, UK, TLX 99382) allow you to implement a full-duplex, digitally encoded voice channel, or to store and retrieve voice information from digital memory. The FX609 codec performs A/D and D/A conversion of the transmitted and received voice information, respectively, and includes on-chip input and output audio filters. You can choose a 16k-, 32k-, or 64k-bps sampling rate and select a 3- or 4-bit companding algorithm.

The encoder section of the FX709 converts an analog audio input into 8-bit CVSD-encoded words for storage in byte-wide memory—a function required for voice mailbox systems. The decoder section reconverts the stored bytes into an audio output. You can operate the encoder and decoder sections simultaneously, and a μ P interface allows you to control the voice-storage and -retrieval process. Both the FX609 and the FX709 are 5V CMOS devices. They cost approximately £6 and £10 (1000), respectively.

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*DC-1000 MHz (all 75 ohm or 30 dB models) DC-500 MHz (all 40 dB models)

MODEL AVAILABILITY

Model no. = a series suffix and dash number of attenuation.

Example: CAT-3 is CAT series, 3 dB attenuation.

- denotes 75 ohms; add -75 to model no.
- denotes 50 ohms

ATTEN	SAT (SMA)	CAT (BNC)	NAT (N)	TAT (TNC)
1	●	●	●	●
2	●	●	●	●
3	●	● ■	●	●
4	●	●	●	●
5	●	●	●	●
6	●	● ■	●	●
7	●	●	●	●
8	●	●	●	●
9	●	●	●	●
10	●	● ■	●	●
12	●	●	●	●
15	●	● ■	●	●
20	●	● ■	●	●
30	●	●	●	●
40	●	●	●	●

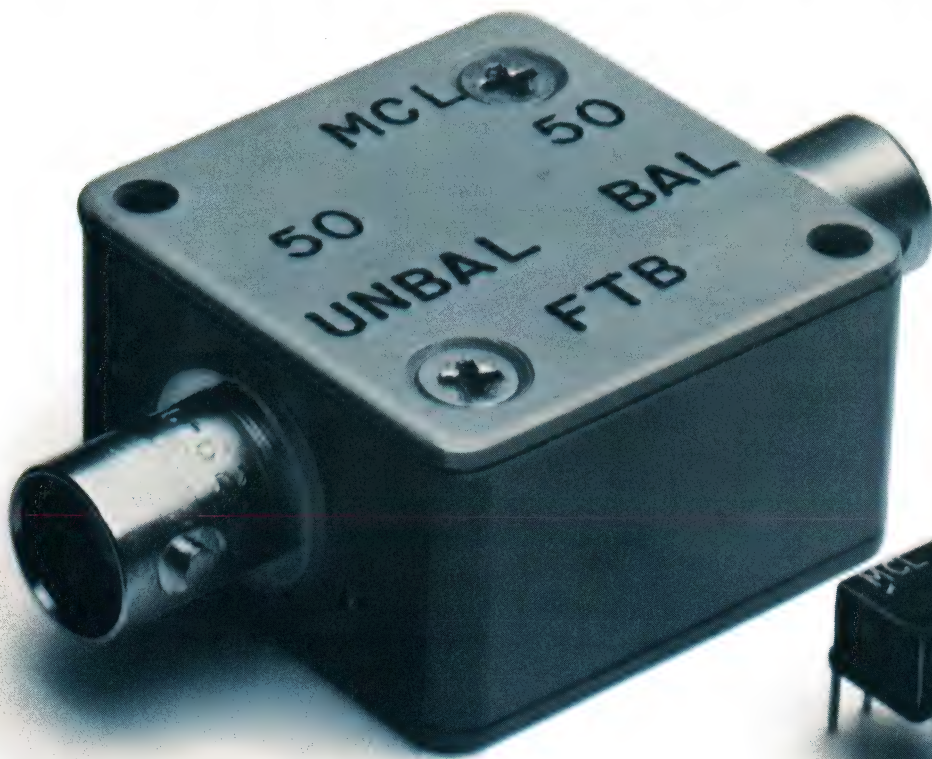
PRICING (1-49 qty.): CAT (BNC)..\$11.95, SAT (SMA)..\$14.95
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CIRCLE NO 197

EDN September 4, 1986

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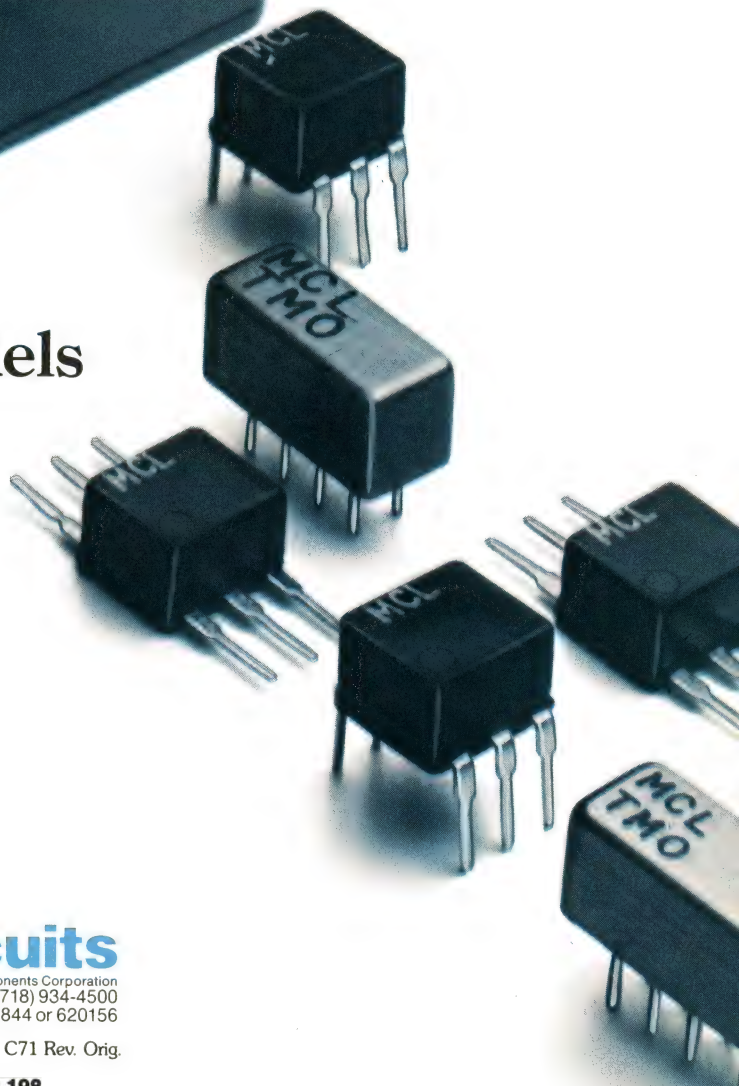


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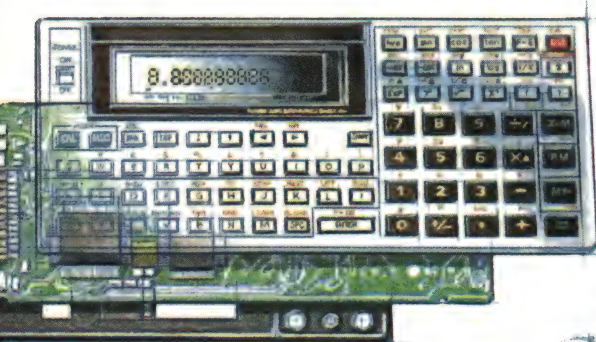
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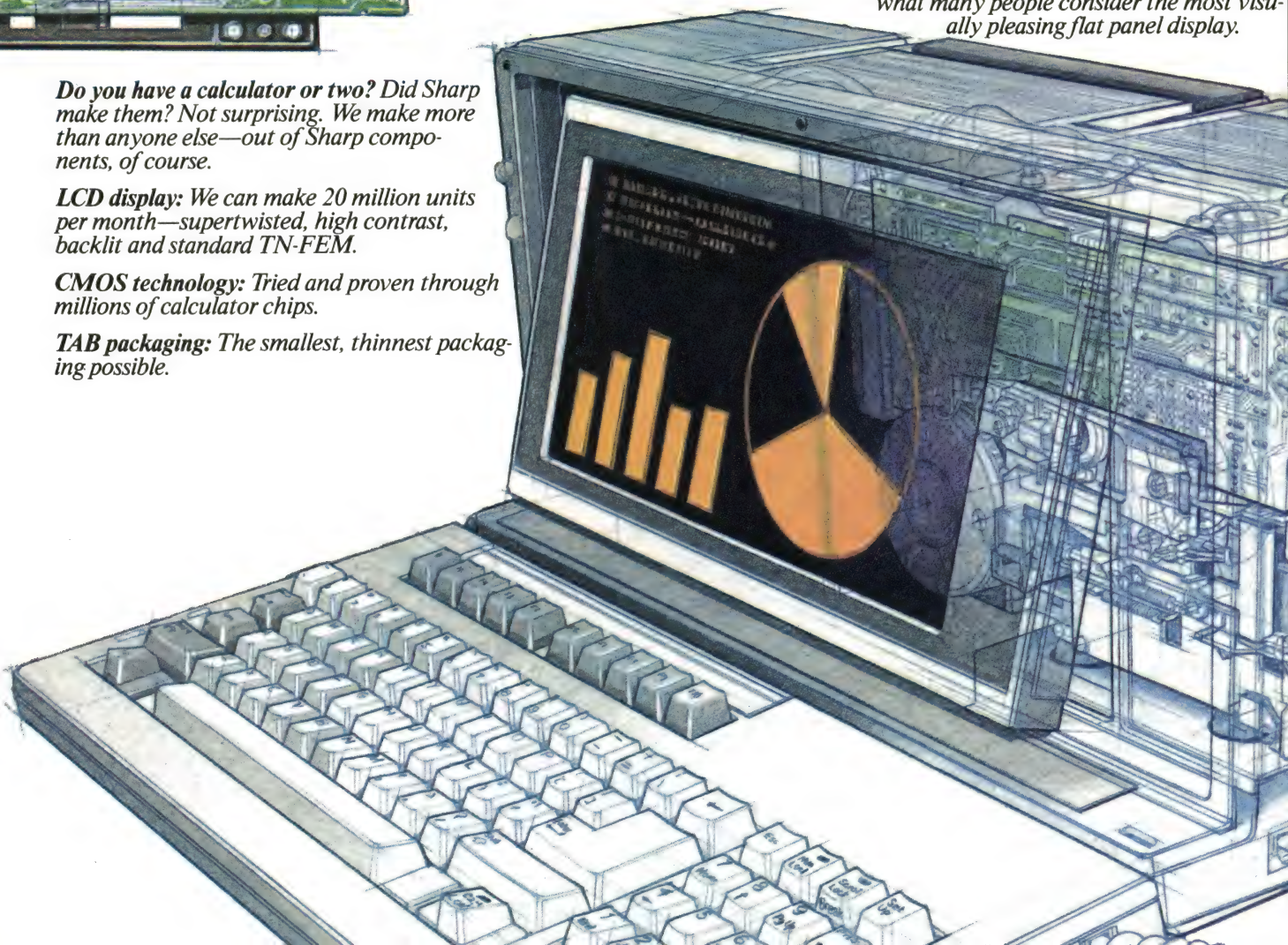
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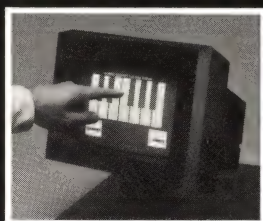
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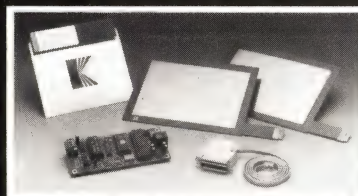
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DRAM-2	2MB	190/300	Parity
SRAM-1	128KB	160/160	Bat. Backup
SRAM-2	512KB	160/160	Bat. Backup
RR-1	128KB to 1MB	300/300	RAM/ROM

32 Bit

Model	Capacity	Write/Read (nsec)	Features
DRAM-E3M/S	1 to 7MB	70/250	Parity
DRAM-E4M/S	4 to 28MB	70/250	Parity
DRAM-5	2 or 4MB	140/270	EDC
SRAM-3	1MB	80/220	Bat. Backup
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CIRCLE NO 11

SIGNALS & NOISE

Engineers concerned about professional recognition

Dear Editor:

In Great Britain, the professional debate on the status and remuneration of engineers has been going on for years now. We are constantly being told that engineers in other countries, particularly West Germany and the United States, enjoy higher status, so it is interesting to read that, in the USA at least, engineers seem to be just as concerned about professional recognition.

Your editorial on the Money Stream Theory (EDN, June 12, pg 51) presented a very convincing argument that engineers are destined for only moderate financial success and prestige. Still, the American phenomenon of start-up companies is a shining example of how engineers can capitalize on their knowledge and move closer to the money stream. The Silicon Valley startups are an inspiration indeed, but few engineers are willing or able to take this sort of risk to better themselves.

*Sincerely yours,
Michael J Bosman
Sandbach, Cheshire, England*

Annunciator circuit can't speak

Dear Editor:

Apparently, Charles Mitchell hasn't tested the circuit he offered in his article "Annunciator gives audible pulse count," which appeared in the Design Ideas section of EDN's June 12 issue (pg 209). The circuit will not, as promised, deliver "a voice report on the total count (nine or less)." Not in any terrestrial language, at least.

The SPO256 speech processor is allophone based. An allophone is a unit of speech that corresponds to the position of a phoneme in a word. Mr Mitchell's device will, at best, speak Yiddish at the count of 5 (it will say "oy"). Counts 0 through 4

are various durations of silence, 6 will sound like "ay," and 7 through 9 can't be pronounced without spitting.

Each of the 64 addresses in the internal ROM of the SPO256 accesses a different allophone. Words are built by sequentially selecting addresses corresponding to the desired allophones. For example, it takes the sequential selection of allophones at addresses 0BH, 18H, 06, and 0BH for this chip to pronounce the word "nine." A typical application requires that this chip be driven by a microprocessor.

*Sincerely yours,
Alan M Taren
Leeds & Northrup Co
North Wales, PA*

Corrections

The article "Optical disk drives expand workstation capacities" (EDN, December 26, 1985, pg 34) contained an incorrect phone number for Laserdrive Ltd. The correct phone number is (408) 970-3600.

In the products section of the article "Electro/86" (EDN, May 1, pg 123), the ML4100B logic analyzer (from Arium Corp) mentioned on pg 140 is now called the ML4100CL; it costs \$2995. Further, the article incorrectly states that the analyzer's 32-bit logic pod can apply control signals to the target machine. In fact, the pod is passive and cannot apply signals to the system under test.

YOUR TURN

EDN's Signals and Noise column provides a forum for readers to express their opinions on issues raised in the magazine's articles or on any topic that affects the engineering industry. Send your letters to the Signals and Noise Editor, 275 Washington St., Newton, MA 02158. We welcome all comments, pro or con. All letters must be signed, but we will withhold your name upon request. We reserve the right to edit letters for space and clarity.

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Max. Timing Accuracy	.55%	.55%
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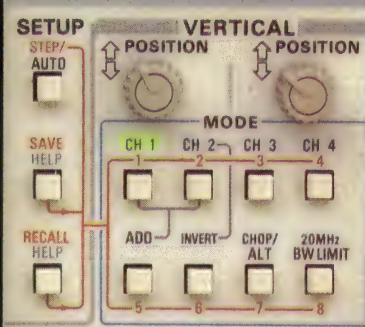
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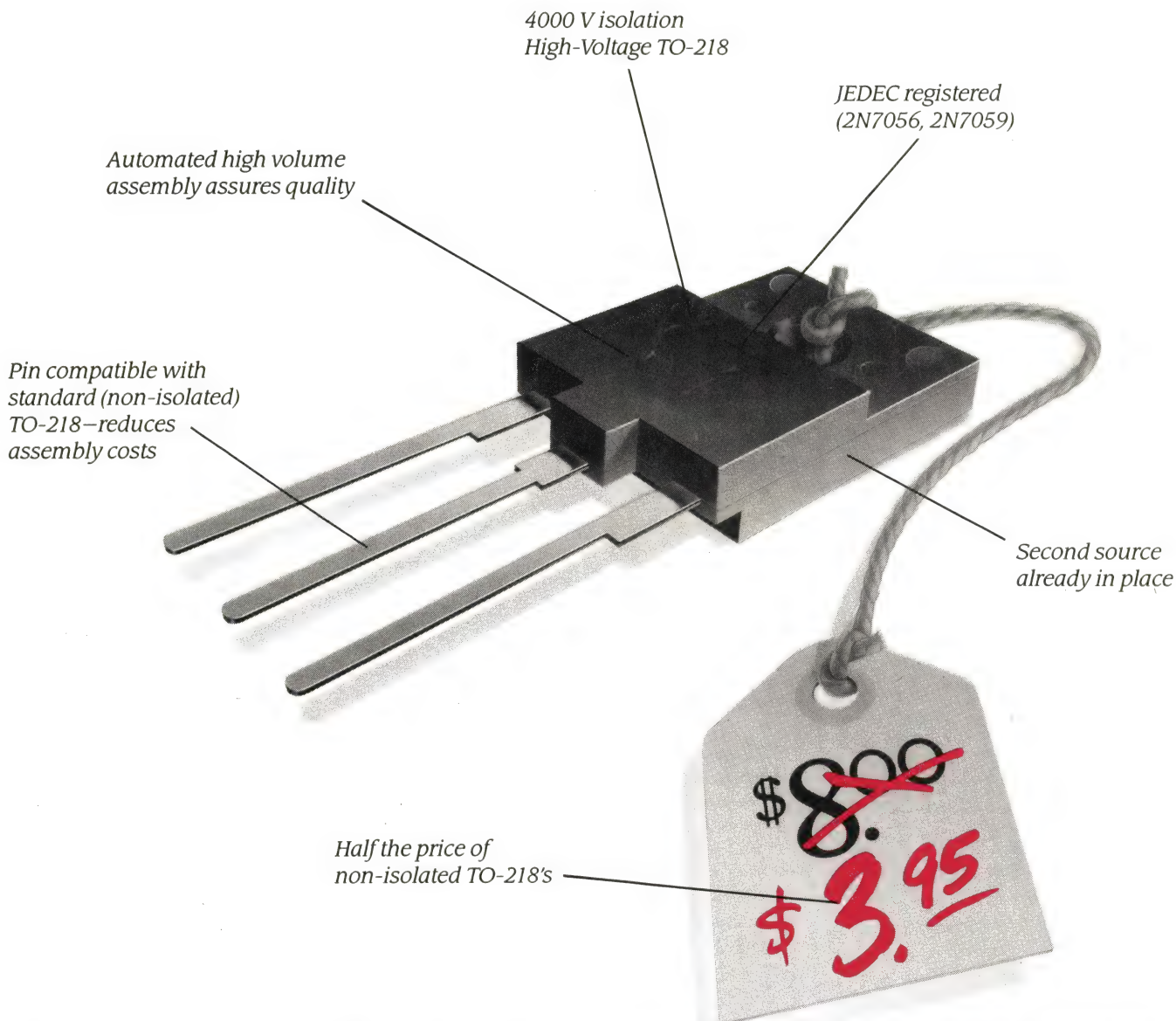
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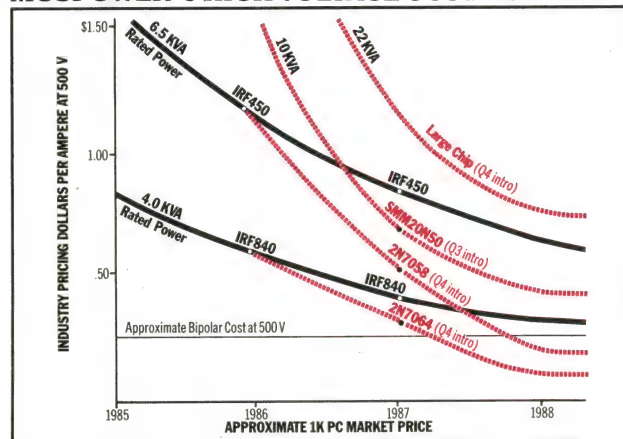
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CALENDAR

Modern Electronic Packaging, Santa Clara, CA. Technology Seminars, Box 487, Lutherville, MD 21093. (301) 269-4102. September 9 to 11.

International Videotex Industry Exposition and Conference, New York, NY. Videotex Industry Association, 1901 N Fort Myer Dr, Suite 200, Rosslyn, VA 22209. (703) 522-0883. September 15 to 17.

Printed Wiring Board Assemblies—Processes, Techniques, and Equipment (short course), Milwaukee, WI. Peter Tocups, Center for Continuing Engineering Education, University of Wisconsin-Milwaukee, 929 N 6th St, Milwaukee, WI 53203. (414) 224-3952. September 15 to 17.

Euromicro '86 (Symposium on Microprocessing and Microprogramming), Venice, Italy. Euromicro, Box 217, 7500 AE Enschede, The Netherlands. (31) (53) 338799. September 15 to 18.

Modern Power Conversion Design Techniques (short course), Santa Clara, CA. E/J Bloom Associates, 115 Duran Dr, San Rafael, CA 94903. (415) 492-8443. September 15 to 19.

5th Annual Conference of the American Voice I/O Society, Alexandria, VA. American Voice I/O Society, Box 60940, Palo Alto, CA 94306. (408) 742-2539. September 16 to 18.

Fall National Design Engineering Show and Conference, New York, NY. Cahners Exposition Group, 999 Summer St, Stamford, CT 06905. (203) 964-0000. September 16 to 18.

Semicon/East '86, Boston, MA. Semiconductor Equipment and Materials Institute, 625 Ellis St, Suite 212, Mountain View, CA 94043. (415) 964-5111. September 16 to 18.



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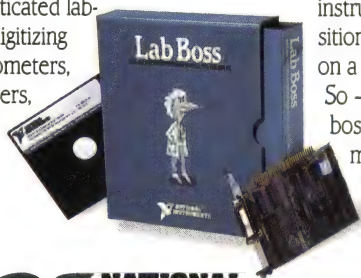
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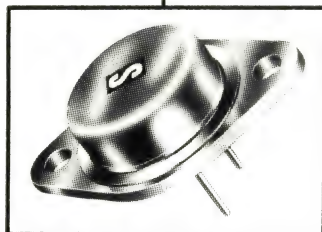
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CALENDAR

Sensors Expo, Chicago, IL. Expocon Management Associates, 3695 Post Rd, Southport, CT 06490. (203) 259-5734. September 17 to 19.

IBM PC Microcomputer Interfacing, Scientific Instrument Automation, and Control, Charlotte, NC. Center for Continuing Education, Virginia Tech, Blacksburg, VA 24061. (703) 961-5182. September 18 to 20.

12th European Conference on Optical Communication, Barcelona, Spain. Central de Congresos, SA, Avda General Peron, 26, 28020 Madrid, Spain. (34) (1) 4551088. September 22 to 25.

Ultratech '86, Long Beach, CA. Society of Manufacturing Engineers, Box 930, Dearborn, MI 48121. (313) 271-0023. September 22 to 25.

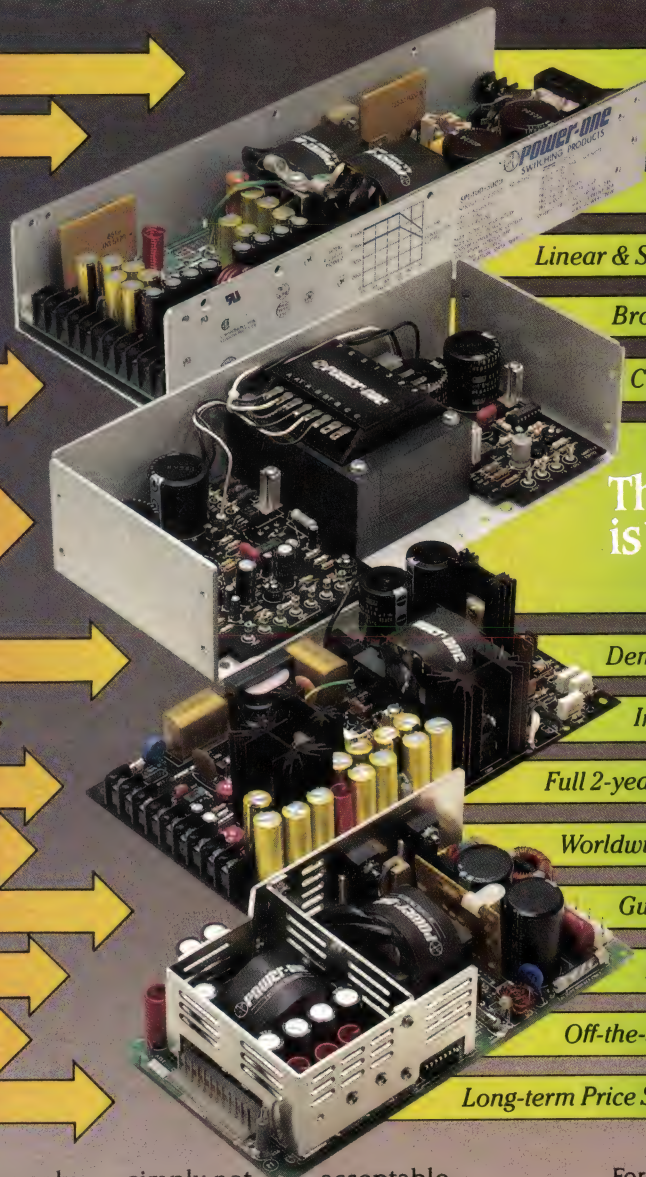
Analog Applications Seminar, Los Angeles, CA. Precision Monolithics, 1500 Space Park Dr, Santa Clara, CA 95054. (800) 843-1515; in CA, (800) 826-9664. September 23.

Nepcon Southwest, Dallas, TX. Cahners Exposition Group, Box 5060, Des Plaines, IL 60017. (312) 299-9311. September 23 to 24.

Artificial Intelligence and Advanced Computer Technology Conference and Exhibition/Europa '86, Wiesbaden, West Germany. TCM Expositions, Exchange House, 33 Station Rd, Liphook, Hants GU30 7DN, UK. (44) 0428-724660. In the US, Tower Conference Management, 331 W Wesley St, Wheaton, IL 60187. (312) 668-8100. September 23 to 25.

Canadian High Technology Show, Toronto, Ontario. Canadian High Technology Week, 2487 Kaladar Ave, Suite 214, Ottawa, Ontario, K1V 8B9. (613) 731-9850. September 23 to 25.

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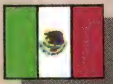
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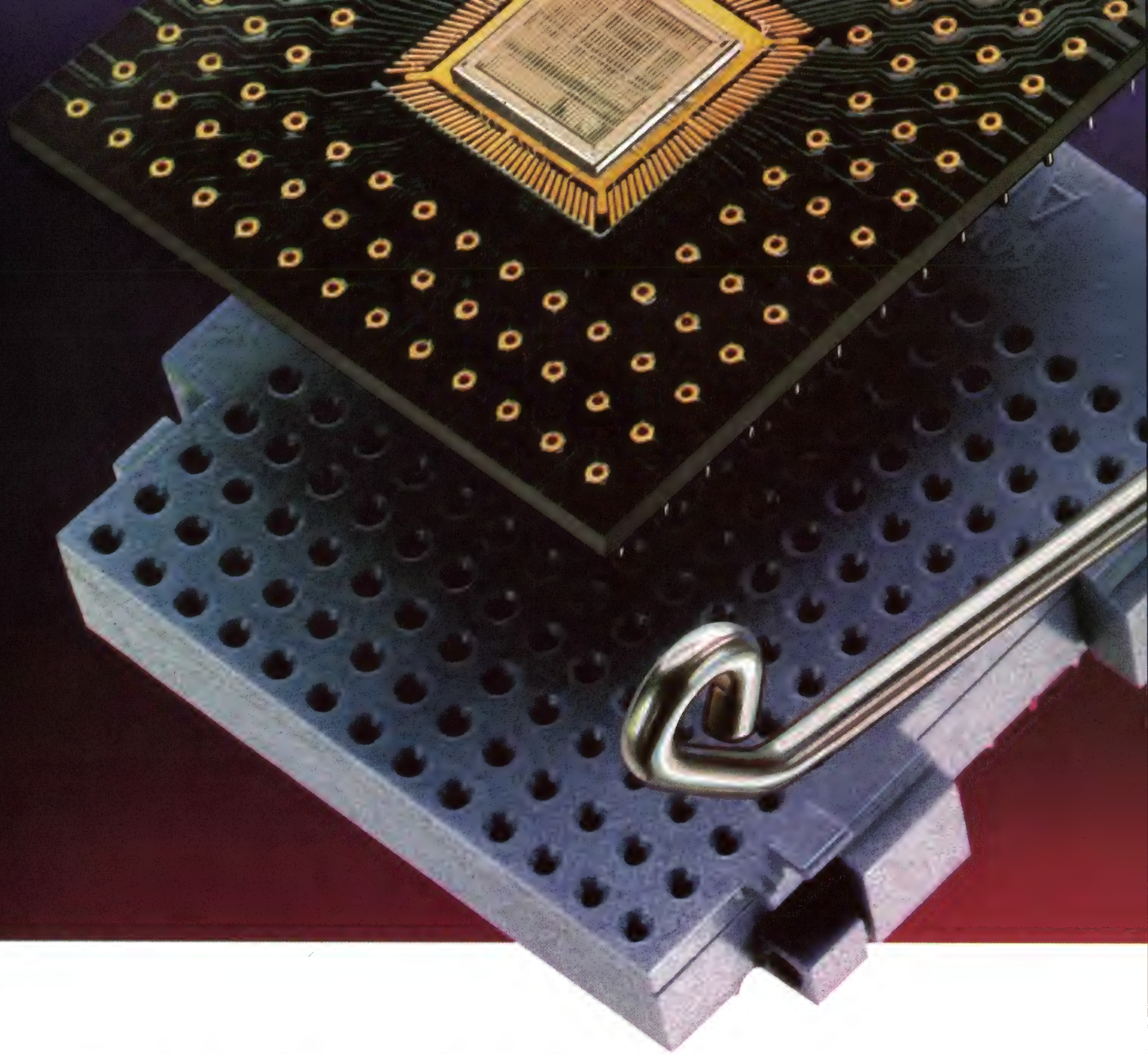
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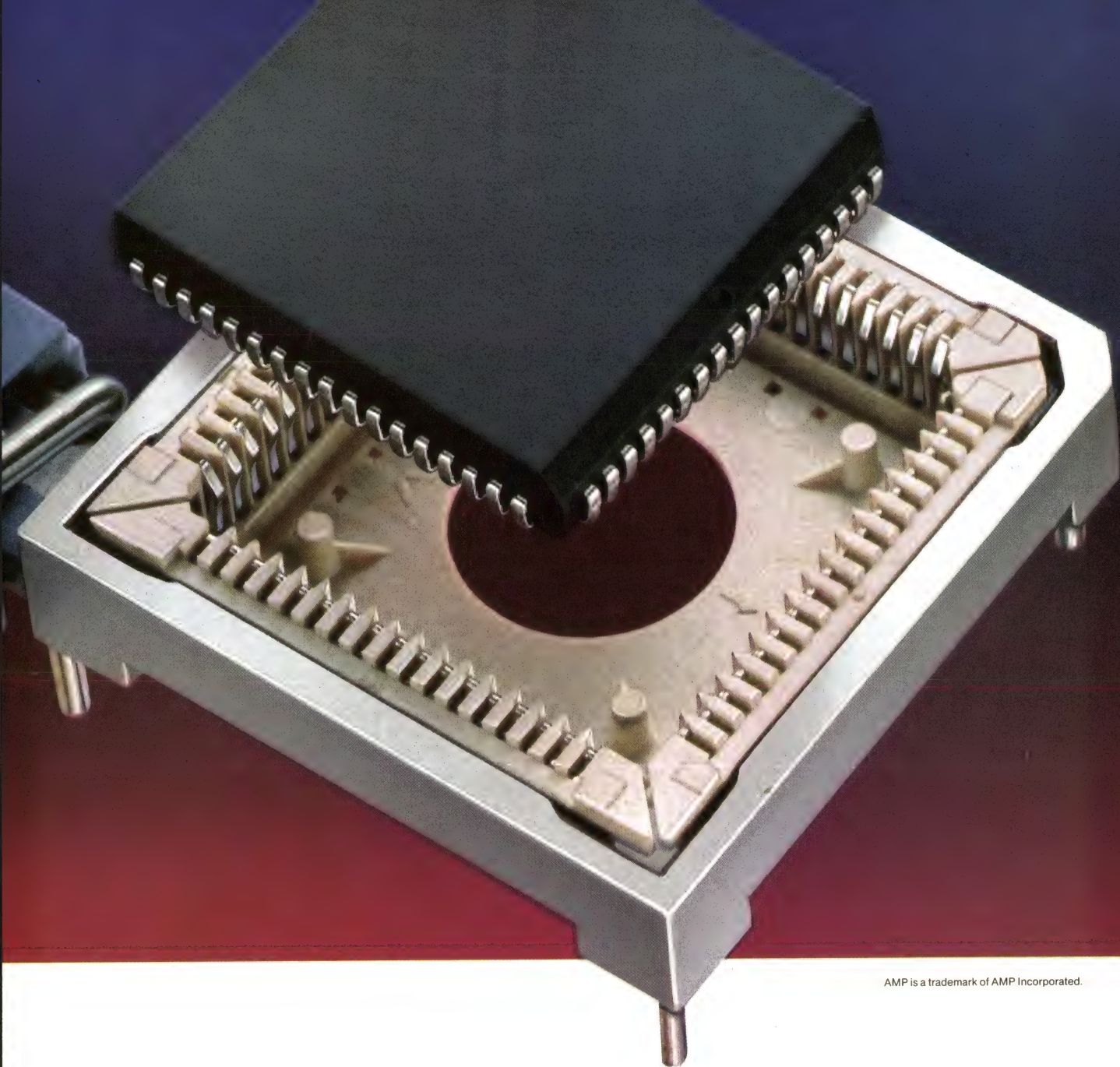
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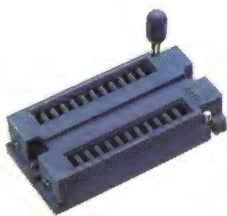
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CIRCLE NO 83

AMP Interconnecting ideas

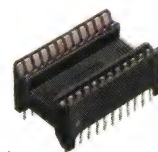
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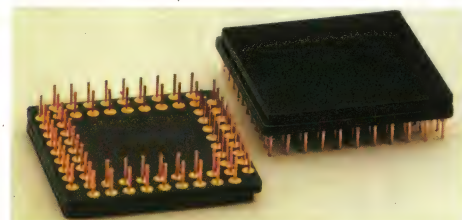
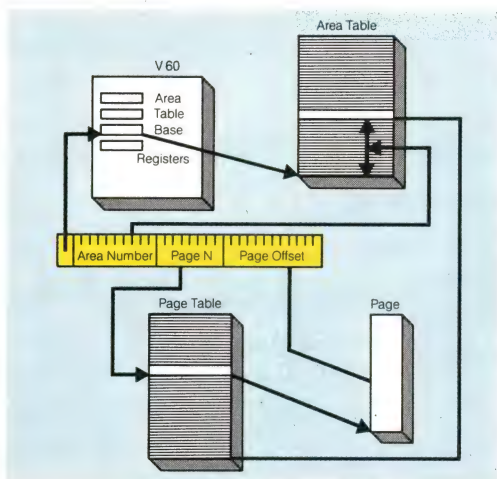
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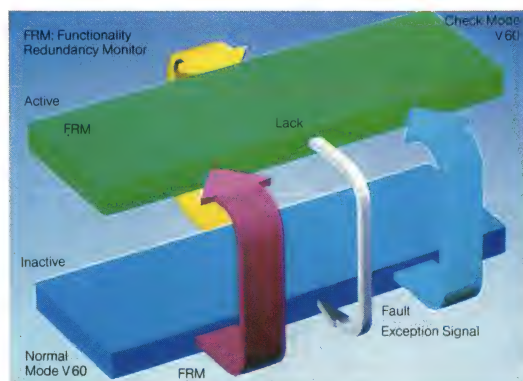


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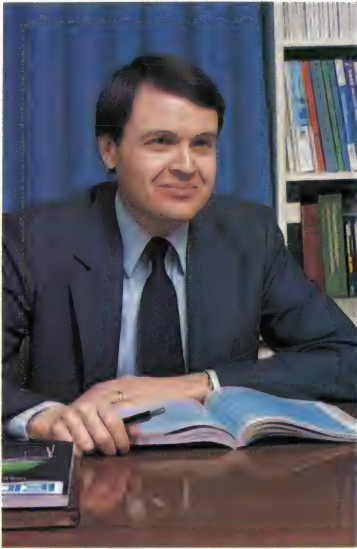
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EDITORIAL

Software creativity—discipline=a mess



The costs and the complexity of software development have reached staggering proportions. According to Digital Equipment Corp, US companies spend \$100 billion a year for software maintenance alone, a sum greater than the GNP of all but a few countries. Yet the tools of computer-aided software engineering, which can reduce software costs, go largely ignored.

Why isn't CASE employed more? I see four main reasons. First, it's not cheap (although it can easily pay for itself in increased productivity). Second, many potential users aren't familiar with what CASE can do. Third, many software developers put too much emphasis on the back end of the development process (coding and debugging) and give short shrift to the critical front-end steps (specification and design) where existing CASE tools can help the most. The fourth reason is that many software developers fear CASE will diminish the creative aspects of their design work.

Why do they have this fear? My theory is that they equate discipline in the software-development process—something that CASE does indeed promote—with reduced creativity. In other words, they accept the absurd notion that a creative mind is a messy mind. Some of them may even flatter themselves via faulty reasoning: "Creative people are disorganized; I am disorganized; therefore, I am creative." Perhaps they need reminding that even though messy people who do good work are, indeed, often considered creative, messy people who do *poor* work are often considered slob. When I hear software developers say they're not interested in CASE, I wonder if they're more interested in being "creative" than in getting a job done.

CASE as it now exists isn't perfect, but it's a start. More tools are needed—design verification and code generation, for example—and many of those tools will have to wait until artificial intelligence makes them feasible. In the meantime, available tools for structured analysis and design can be of significant benefit, especially on large projects involving many people.

Eventually, CASE won't be an option for serious software developers; its use will be mandatory just to remain competitive. To ensure your place in the future world of software, you owe it to yourself to start exploring CASE now. As you do, bear in mind that software creativity needs to be balanced with good old-fashioned engineering discipline. For every messy, creative genius who creates a great program, there are probably 10 more so-called geniuses who create nothing but messes.

Gary Legg
Editor

WEEK 45

Presenting the I-only-have-a-few-milliwatts-to-spare microprocessor. The 80C31 8-Bit CMOS Single-Chip microprocessor from AMD.

If you need a low-power device, how does this sound? 120 milliwatts of operating power and 100 microwatts of standby power. With an operating speed of 12 MHz.

80C31

Less is plenty.

The 80C31 is a second source for Intel's 80C31. It's a plug-in replacement. And just like Intel's, you can use our 80C31 right off the shelf because there's no ROM.

If you like the 80C31 you'll also like the rest of our single-chip microcomputer family: The 8051 single-chip microcomputer, the 8053 with twice the ROM and the forthcoming CMOS 80C51. And the EPROM versions: The 8751 and the 8753.

The 80C31: When you need a low-power device, it's good to know AMD has one designed to make the most out of the least.

CIRCLE NO 181

WEEK 46

Sick of working in half the space you need? Heartbroken at having to leave out those exquisite little bits of code? AMD has the cure. The 8053 Single-Chip Microcomputer.

8053

4K ROM free. No green stamps.

The 8053 is just like our high-spirited 8051 except you get 4K bytes of extra ROM. Free. Just like the 8051, it has two 16-bit timers, four 8-bit I/O ports and 128K x 8 RAM. But where the 8051 has a 4K x 8 ROM, the 8053 has an 8K x 8 ROM.

And all this doesn't cost any more than the 8051.

For prototyping and development work, we have the EPROM version: The 8753.

We think giving 4K ROM free is a very generous offer. You'll never miss the stamps.

CIRCLE NO 182

WEEK 47

Just remember AMD's new 4K x 4 CMOS SRAMs: The Am99C58 and the Am99C59. They have the fastest 16K CMOS SRAM access time around: 20ns. But even at speeds like that, they don't forget what they're made of: An advanced CMOS. So they don't use much power.

Am99C58/59

The fastest way to improve your memory.

What else could you ask for in an SRAM?

You could ask for separate I/O. Okay. Both chips have separate I/O ports to eliminate bus contention snarls and give you faster throughput. Being able to fly through like that increases performance by 20%.

The Am99C58 also has a chip enable function which automatically powers down the chip when deselected. And that decreases power consumption by over 70%.

The Am99C59 has a scorching 10ns chip select access time which will increase memory system throughput. It's just the thing for cache memory applications.

With the fastest access times around and separate I/O, AMD's Am99C58 or Am99C59 CMOS SRAMs give you the options you need to improve your memory. Fast. And that's worth remembering.

CIRCLE NO 220

WEEK 48

It's about time someone met the needs of the stingy. And AMD did it. With our new Am29C841 High-Performance CMOS 10-Bit Latch. Another member of AMD's Bus Interface Family.

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Am29C841

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Use the Am29C841 instead of a bipolar latch when you need only moderate drive capability. The CMOS Am29C841 provides 24mA drive. Its MOS/TTL compatible inputs and outputs mean you can use it with both bipolar and MOS systems.

You don't necessarily have to be stingy to want a low-powered, high-performance latch like the Am29C841. You just have to be wise, far-sighted and exceptionally bright.

CIRCLE NO 221

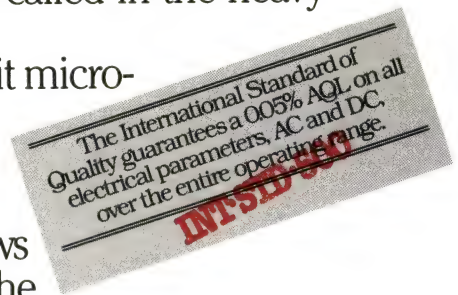
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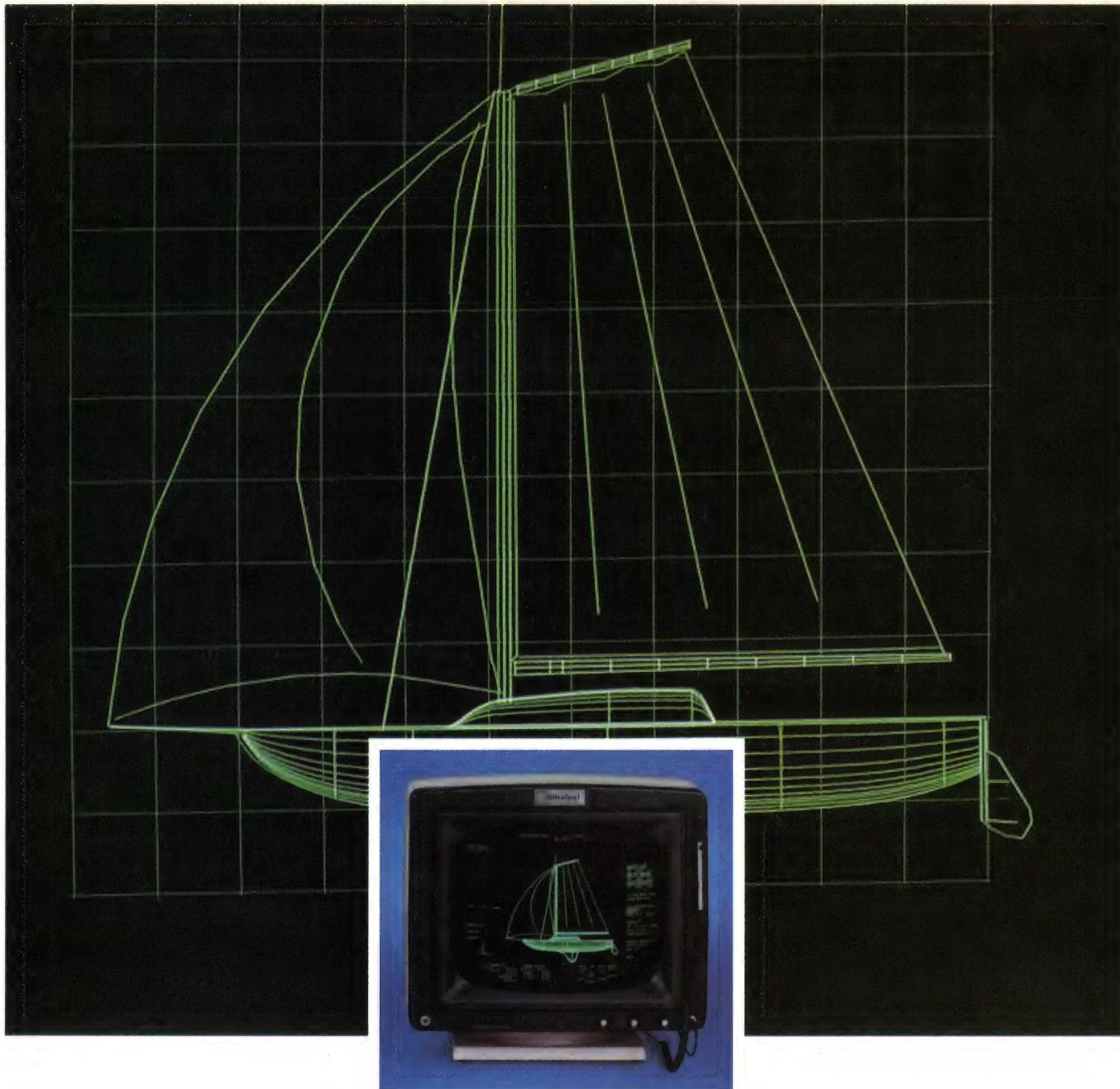
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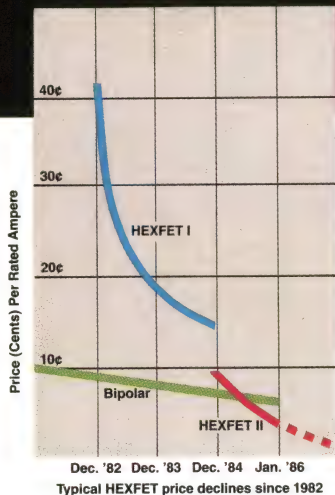
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Increased scale lengths, math functions make handheld DMMs general-purpose R&D tools

Peter Harold, *European Editor*

Thanks to single-chip- μ C control, handheld digital multimeters now offer measurement performance and features that were formerly found only on benchtop instruments. For example, handheld DMMs can now perform such computation functions as calculation of decibel ratios or offset-relative measurements. The instruments' analog displays, which take the form of bar graphs or simulated analog meters, help you fine-tune electronic circuitry.

These handheld DMMs also offer increased scale lengths: The instruments, which once provided only $3\frac{1}{2}$ -digit scale lengths, now offer $4\frac{1}{2}$ or $4\frac{3}{4}$ digits. The multimeters' basic dc-voltage accuracies have improved to 0.1% or less, and some of the instruments make ac measurements with true-rms accuracy. Further, some handheld DMMs can double as logic testers, frequency counters, or sensitive thermometers.

Improvements over the last five years in the design of CMOS A/D converters, low-cost voltage references, and attenuator networks have brought the price of a basic $3\frac{1}{2}$ -digit handheld DMM (sporting dc/ac voltage, dc/ac current, and resistance functions as well as a basic dc accuracy of 0.1% or better) to under \$200. However, for a few dollars more, you can own a handheld DMM with the same measurement performance but with advanced user features—such as true-rms ac measurement, offset relative measurements, and decibel computations—that make it a useful general-purpose R&D tool. In addition, because of the handheld DMMs' \$250 to \$350 price tag, every



The analog bar graph incorporated into the displays of Philips's PM2618 and PM2718 $4\frac{1}{2}$ -digit DMMs is optimized for observing signal trends. It allows you to null a circuit to zero, or a preset value, with an accuracy of 0.3% of range. These DMMs also feature relative, decibel, and frequency measurement, and they allow for totally electronic recalibration.

engineer can have his own instrument. For a summary of the measurement capabilities and added features you'll find on some currently available models, refer to **Table 1**, which begins on pg 62.

Choosing your DMM

Choosing a handheld DMM for its dc-voltage performance is relatively easy, because you can expect the DMM's basic dc-measurement accu-

racy spec to be valid for all input ranges except the 1000V range. The input impedance on dc voltage ranges for the DMMs listed in **Table 1** is around 10 M Ω , so for most applications, these instruments won't cause circuit-loading errors.

To take measurements of dc voltage from circuitry with a high source impedance, however, you'll need to use an instrument with a higher input impedance. The B&K

TECHNOLOGY UPDATE

Precision 2820, the North American Soar 3430 and 3450, and the Triplet 4750, for example, all feature an input impedance of greater than 1000 M Ω on the 250-mV dc-voltage range; the Fluke 8060A and 8062A feature this same high input impedance on both the 200-mV and 2V dc voltage ranges.

The basic resistance-measurement specifications in **Table 1** are also valid over several measurement ranges—usually from the DMM's first kilohm range to its first megohm range. The only handheld DMMs listed that differ appreciably from this rule are the B&K Precision 2820, the Soar 3430 and 3450,

and the Triplet 4750. For these models, the basic resistance-measurement accuracy specifications in **Table 1** apply to ranges as high as the 250-k Ω range, but for the 2500-k Ω range, the spec is $\pm(0.5\%+2$ digits).

Resistance-measurement accuracies in the higher megohm ranges are always 1% or more because of the noise problems in those ranges. If you have to measure very high ohmic values, you can use Fluke's Models 27 and 8060A handheld DMMs, which feature conductance ranges of 32 nS and 2000 nS, respectively. The conductance range of the 3 $\frac{3}{4}$ -digit Model 27 has a resolution

of 0.01 nS and an accuracy of $\pm(2\%+10$ digits). The conductance range of the 4 $\frac{1}{2}$ -digit 8060A has a resolution of 0.1 nS and an accuracy specification of $\pm(0.5\%+20$ digits).

Average or true-rms ac

Choosing a DMM for its ac-voltage performance is not as simple as choosing one for its dc performance. First, you must decide whether you require an average-sensing or a true-rms-sensing DMM. If you want to measure the rms value of nonsinusoidal waveforms, you'll need to use a true-rms-sensing DMM; if not, you can use an average-sensing DMM.

TABLE 1— REPRESENTATIVE HANDHELD DMMs WITH ADVANCED FEATURES

MANUFACTURER	MODEL NUMBER	FULL-SCALE COUNT (DIGITS)	DC VOLTAGE		AC VOLTAGE				RESISTANCE	
			RANGES	BASIC ACCURACY*	SENSE	CREST FACTOR	RANGES	BASIC ACCURACY*	RANGES	
B&K PRECISION	2820	24,999	250 mV TO 1000V	0.04%+2D	TRUE RMS	3	250 mV TO 750V	0.5%+10D	250 Ω TO 25 M Ω	
BBC-METRAWATT/GOERZ	M2037	31,000	300 mV TO 1000V	0.05%+2D	TRUE RMS	5	300 mV TO 1000V	0.5%+30D	300 Ω TO 30 M Ω	
	M2042	30,000	300 mV TO 1000V	0.05%+1D	TRUE RMS	6	300 mV TO 1000V	0.4%+30D	300 Ω TO 300 M Ω	
BECKMAN INDUSTRIAL	DM800	19,999	200 mV TO 1000V	0.05%+3D	AVERAGE	—	200 mV TO 750V	0.75%+20D	200 Ω TO 20 M Ω	
	DM850	19,999	200 mV TO 1000V	0.05%+3D	TRUE RMS	3**	200 mV TO 750V	0.75%+20D	200 Ω TO 20 M Ω	
FLUKE	27	3200	320 mV TO 1000V	0.1%+1D	AVERAGE	—	320 mV TO 1000V	0.5%+3D	320 Ω TO 32 M Ω AND 32 nS	
	8060A	19,999	200 mV TO 1000V	0.04%+2D	TRUE RMS	3	200 mV TO 750V	0.5%+10D	200 Ω TO 300 M Ω AND 2000 nS	
	8062A	19,999	200 mV TO 1000V	0.05%+2D	TRUE RMS	3	200 mV TO 750V	0.5%+10D	200 Ω TO 300 M Ω	
PHILIPS	PM2518	19,999	1V TO 1000V	0.1%+2D	TRUE RMS	2	1V TO 1000V	0.5%+10D	1 k Ω TO 100 M Ω	
	PM2618	19,999	1V TO 1000V	0.1%+2D	TRUE RMS	2	1V TO 1000V	0.5%+10D	1 k Ω TO 100 M Ω	
	PM2718	19,999	1V TO 1000V	0.05%+2D	TRUE RMS	2	1V TO 1000V	0.3%+10D	1 k Ω TO 100 M Ω	
NORTH AMERICAN SOAR	3430	24,999	250 mV TO 1000V	0.04%+2D	TRUE RMS	3	250 mV TO 750V	0.5%+10D	250 Ω TO 25 M Ω	
	3450	24,999	250 mV TO 1000V	0.07%+2D	AVERAGE	—	250 mV TO 750V	0.5%+10D	250 Ω TO 25 M Ω	
TRIPLET	4700	19,999	200 mV TO 1000V	0.04%+2D	TRUE RMS	3	200 mV TO 750V	0.5%+10D	200 Ω TO 20 M Ω	
	4750	24,999	250 mV TO 1000V	0.04%+2D	TRUE RMS	3	250 mV TO 750V	0.5%+10D	250 Ω TO 25 M Ω	

* ALL ACCURACY SPECIFICATIONS ARE $\pm$ (% OF READING+DIGITS). WHEN COMPARING ACCURACY SPECIFICATIONS, NOTE THAT 1 DIGIT ON A 3 $\frac{1}{2}$ - OR 3 $\frac{3}{4}$ -DIGIT DMM IS EQUIVALENT TO 10 DIGITS ON A 4 $\frac{1}{2}$ - OR 4 $\frac{3}{4}$ -DIGIT DMM. FOR SCALE LENGTH SEE FULL-SCALE COUNT COLUMN.

** INCURS ADDITIONAL ERRORS.

TECHNOLOGY UPDATE

An average-sensing DMM rectifies the ac input and then measures the mean rectified value, which it internally scales to an rms value. The scaling factor it uses—the ratio between a sine wave's mean value and its rms value—doesn't hold true for nonsinusoidal waveforms, for which it can cause measurement errors of several percent. (For example, measurements of square waves would be in error by about 11%.)

True-rms-sensing DMMs evaluate the rms value of an input waveform directly: They incorporate a dedicated analog computer, usually in the form of log/antilog circuitry, that performs the root-mean-square

computation. As a result, true-rms-sensing DMMs can—within limits—measure nonsinusoidal waveforms. The DMMs are limited in that their rms-computation circuitry can't always handle the dynamic range of the instantaneous signal presented to the input.

You can judge a DMM's ability to cope with various ac input waveforms by looking at the instrument's crest-factor specification. Crest factor is the ratio between a waveform's peak value and its rms value—for example, the crest factor for a sine wave is 1.414, and the crest factor for a square wave is 1. A DMM maintains its specified ac-

measurement accuracy for all ac input waveforms whose crest factors don't exceed the DMM's crest-factor rating. Crest-factor ratings for the instruments in **Table 1** range from 2 to 6.

Although the crest-factor rating (2) for Philips's PM2518, PM2618, and PM2718 handheld DMMs is at the low end of this range, these instruments incorporate circuitry that assesses the input signal's waveshape and provides you with a display indicating crest-factor overloads. This feature is useful when you don't know, or can't easily measure, an ac waveform's crest factor.

When you're assessing a DMM's

	BASIC ACCURACY*	DC AND AC CURRENT RANGES	dBm RANGE	RELATIVE MEASUREMENT	MAX/MIN	FREQUENCY-MEASUREMENT RANGE	LOGIC FUNCTIONS	ANALOG READOUT	PRICE
	0.06%+2D	250 mA AND 10A	-50 TO +59.7	•	PEAK HOLD	10 Hz TO 100 kHz		—	\$357
	0.2%+2D	300 μ A TO 15A	-100 TO +62	•	PEAK HOLD	—		SIMULATED ANALOG METER	DM 1045
	0.1%+1D	3 mA TO 20A	-100 TO +62	•	—	—		SIMULATED ANALOG METER	DM 1400
	0.1%+3D	200 μ A TO 10A	—	—	—	20 Hz TO 200 kHz		—	\$169.95
	0.1%+3D	200 μ A TO 10A	—	—	—	20 Hz TO 200 kHz		—	\$219.95
	0.2%+1D	320 μ A TO 10A	—	•	MAX/MIN	—		LINEAR BAR GRAPH	\$259
	0.07+2D	200 μ A TO 2A	-50 TO +59.72	•	—	12 Hz TO 200 kHz (700 kHz SELECTABLE)		—	\$349
	0.1%+2D	200 μ A TO 2A	—	•	—	—		—	\$295
	0.3%+10D	20 mA TO 20A	-51 TO +43	•	—	—		—	\$245
	0.3%+10D	20 mA TO 20A	-51 TO +43	•	—	10 Hz TO 200 kHz	•	TREND/NULL INDICATOR	\$295
	0.15%+5D	20 mA TO 20A	-51 TO +43	•	MAX/MIN	10 Hz TO 200 kHz	•	TREND/NULL INDICATOR	\$345
	0.06%+2D	250 mA AND 10A	-50 TO +59.7	•	PEAK HOLD	10 Hz TO 100 kHz		—	\$339
	0.07%+2D	250 mA AND 10A	-50 TO +59.72	•	—	10 Hz TO 100 kHz		—	\$279
	0.25%+2D	2 mA TO 10A	-98 TO +60.28	•	—	—	•	—	\$330
	0.06%+2D	250 mA AND 10A	-50 TO +59.7	•	PEAK HOLD	10 Hz TO 100 kHz		—	\$340

TECHNOLOGY UPDATE



Sealed against the environment and protected from shock and vibration, the Fluke 27 3½-digit DMM withstands use in harsh industrial environments. Its lab features include relative measurements and storage and recall of maximum and minimum values.

lead-resistance errors when you measure resistors of low ohmic value or to determine component deviations from a nominal value. Note, however, that the relative-measurement function on handheld DMMs differs from that found on many benchtop instruments—no handheld DMM lets you enter the reference value numerically, via the keypad. Instead, you must use an appropriate physical source to set up and enter the reference value.

dB or dBm

Most μ P-controlled handheld DMMs also provide a decibel-computation capability for use with their ac-voltage measurement functions. On all the DMMs listed in **Table 1** except BBC-Metrawatt/Goerz's M2042, decibel values computed from ac-voltage inputs are

referenced to 1 mW in 600 Ω , so the dB function actually indicates dBm:

$$\text{dBm} = 20 \log(V_{\text{IN}}/0.7746)$$

On most handheld DMMs, if you want to refer the decibel measurements to other impedances, you'll have to resort to correction charts. The BBC-Metrawatt/Goerz M2042, however, allows you to select the dBm reference to be 1 mW in 150 Ω , 600 Ω , 900 Ω , or 1200 Ω , so for many applications, the M2042 provides a direct measurement of the required dBm value.

In addition to providing dBm measurement for ac-voltage inputs, the Fluke 8060A and Philips PM2618 and PM2718 provide dB measurement for dc-voltage inputs. The Fluke 8060A refers dc measure-

ments to 1 mW in 600 Ω ; the Philips' DMMs refer them to 1 mW in 50 Ω . You can usually operate the dB function and the relative-measurement function simultaneously, so it's easy to establish stage gain or stage loss for, say, frequency-response testing.

The Fluke 27 and Philips PM2718 both feature a max/min capability, which lets them digitally store and recall the highest and lowest readings recorded since the max/min stores were cleared. Hence, you can leave the DMM connected into a circuit for an extended period of time (for as long as the batteries last, or indefinitely if the DMM accepts a line-supply adapter), returning at a later date to record the maximum positive and negative excursions of the input signal. You can also use the function to make peak-to-peak measurements on very-low-frequency ac signals.

The max/min capability on these instruments shouldn't be confused with the peak-hold function provided by B&K Precision's 2820, Soar's 3430, and Triplet's 4750 DMMs. The peak-hold circuit on these DMMs is an analog peak detector and S/H circuit; it records the peak value of short-term changing voltage or current inputs, such as the inrush current that occurs when you power up a power supply. When you use it with the DMMs' temperature function, however, the peak-hold circuit operates digitally, holding the current maximum reading on the display.

Direct temperature readouts

Although most handheld DMMs can measure temperature when you add a suitable platinum resistance thermometer (PRT) or thermocouple probe, some provide a direct readout of temperature. The B&K Precision 2820, Soar 3430, and Triplet 4750 all contain cold-junction compensation and internal scaling, which allow the instruments to accept a standard K-type thermocouple probe. The readout can be in

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12/Z012 e



TECHNOLOGY UPDATE

ac performance, be sure to consider the frequency range over which the instrument's accuracy specifications apply. The basic ac specifications quoted in **Table 1** apply at 500 Hz (at this frequency, all the instruments surveyed exhibit their maximum ac accuracy, which is typically $\pm 0.5\%$). Of the true-rms-sensing DMMs, B&K Precision's 2820, Fluke's 8060A and 8062A, Soar's 3430, and Triplet's 4700 and 4750 DMMs maintain this accuracy to frequencies as high as 10 kHz. These accuracies are generally valid for all ac ranges except the topmost 750V range, although the Fluke 8062A maintains maximum accuracy to 10 kHz only in its 200-mV and 2V ranges.

Philips specifies the ac-voltage frequency response of its handheld DMMs in a slightly different way. The company's PM2518 maintains maximum ac accuracy from 40 Hz to 2 kHz, and the PM2618 and PM2718 maintain maximum accuracy from 40 Hz to 3 kHz. Beyond these upper frequencies, the accuracy is specified as (% reading+number of digits)/kHz. The per-kHz errors for the PM2518, PM2618, and PM2718 are (0.25%+5 digits), (0.17%+3 digits), and (0.1%+3 digits), respectively. The instruments' respective ac-voltage accuracies at 10 kHz, therefore,

are $\pm(2.5\%+50 \text{ digits})$, $\pm(1.7\%+30 \text{ digits})$, and $\pm(1\%+30 \text{ digits})$.

The ac-voltage accuracy of the BBC-Metrawatt/Goerz M2037 and M2042 is specified over a single frequency range from 15 Hz to 20 kHz for voltages as high as 300V. For most handheld DMMs, ac-measurement errors for readings beyond 10 kHz, or on the highest voltage range, rapidly increase to a few percent or more.

Fluke's 8060A provides the best ac performance you can get from a handheld DMM at low voltage levels; the instrument features a 200-mV-range ac accuracy of $\pm(0.2\%+10 \text{ digits})$ between 45 Hz and 1 kHz and $\pm(0.2\%+20 \text{ digits})$ between 1 and 10 kHz. If you need to measure the true-rms value of an ac signal plus its dc component, consider using BBC-Metrawatt/Goerz's M2042 DMM, which has a dc-coupled ac mode.

Of course, to assess ac-measurement errors, you need to know the frequency of the signal you're measuring. For this purpose, as well as for general frequency measurement, several handheld DMMs incorporate frequency counters. These DMMs usually measure frequency by applying the input to a threshold detector and feeding the resultant pulses to the counter,

which is usually associated with the instrument's integrating A/D converter. The ac input attenuator allows you to scale the input signal to suit the threshold detector, thus altering the frequency counter's input sensitivity.

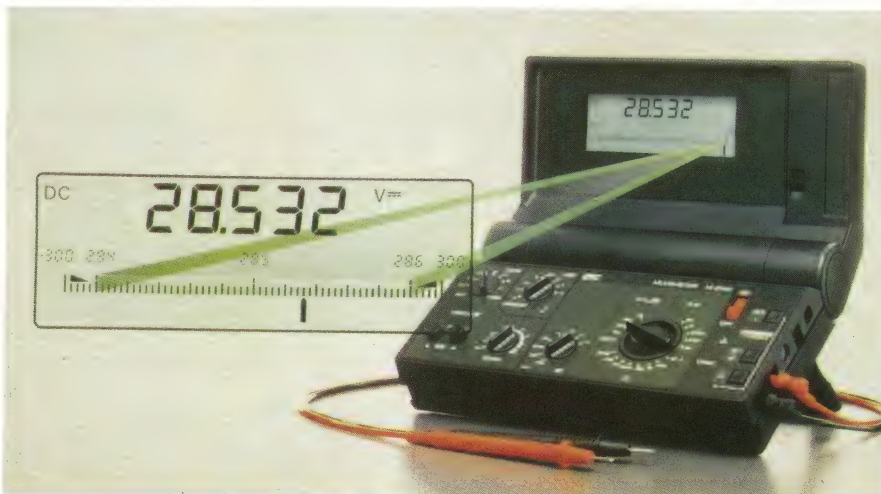
1-chip μ Cs add features

Although many DMMs may satisfy your basic dc- and ac-voltage, dc- and ac-current, and resistance-measurement requirements, it's the instruments with internal μ Ps—normally in the form of single-chip CMOS microcomputers—that offer the extra measurement functions required in an R&D environment.

Several of the DMMs listed in **Table 1**, for example, incorporate a relative-measurement function. By connecting one of these DMMs to a source with the required reference value, you can store the reference value in memory; the DMM automatically subtracts the reference value from subsequent readings before displaying them. Normally, this relative-measurement function is available for all the instrument's measurement functions.

Two DMMs that incorporate the relative-measurement function are BBC-Metrawatt/Goerz's M2037 and M2042, whose folding case design affords a larger display area than the one on most handheld models. This larger area allows the M2037 and M2042 to simultaneously display the actual input value, the set reference value, and the relative value. The M2037 displays all three values digitally to 4 $\frac{3}{4}$ -digit precision, and you can select the relative value for display either in terms of an absolute value or as a percentage deviation. The M2042 displays the relative value on its simulated analog-meter scale. On other DMMs that have the relative-measurement function, you can usually recall the reference on the display via an appropriate sequence of keystrokes.

You can use a DMM's relative-measurement function to eliminate



You can expand the effective scale length of the simulated analog meter on BBC-Metrawatt/Goerz's M2042 DMM to 10m and ± 7500 scale divisions by using the 8-stage zoom feature. The 4 $\frac{3}{4}$ -digit instrument also features dBm computation relative to four different reference impedances.

STANDARDS UPDATE

EMISSION LAWS—COMPUTERS, PERIPHERALS AND ELECTRONIC EQUIPMENT.

FCC Strike Force Sweeps COMDEX. A squad of Federal agents swept through the Atlanta trade show, ticketing 2,500 violators of FCC rules, according to **COMPUTERWORLD**. The FCC reports that \$178,000 in fines was levied and at least one manufacturer was threatened with destruction of its inventory. The FCC rules in Part 15 require that nearly all electronic equipment meet stringent limits. Penalties may include fines, seizures or arrests. Regular FCC representation at major trade shows can be expected.

FCC Compliance at a Guaranteed Rate by a Guaranteed Date is the promise of Dash, Straus & Goodhue, Inc. (617-263-2662), the Northeast's largest research and development firm dedicated to EMI, ESD and Telecom compliance. Under that program, a customer can call DSG and receive, over the phone, a commitment to have a device tested, modified (if necessary), retested and verified within a guaranteed time and for a guaranteed rate. DSG's in-house legal staff prepares in **complete confidence** all necessary applications to the FCC. The firm is prepared to assist clients, should the FCC call.

TELECOM REGULATIONS—FCC PART 68.

Competitor Complaints Lead to Fines. Complaints filed by one manufacturer of digital network channel terminating equipment (NCTE) led to fines being levied on its competitors. Often a source of FCC sanctions, competitors' complaints are given a high priority by the FCC. Nearly all devices which hook to the telephone network must be registered with the FCC and must comply with the Part 68 regulations.

Selling to Europe May Become Easier under new Common Market accords. A new Common Market Council Directive has taken the first step in providing uniform Common Market regulations over standards that customer-premise equipment must meet. The full effect of the Directive is expected to be felt in one to two years.

DSG Can Review Products Worldwide. One of the few labs both FCC listed and Canadian approved, the firm now announces it has also begun work to aid manufacturers to sell in the newly opened Japanese and British telecommunications markets.

SAFETY

"Lawyers are on the Attack", according to the insurance industry, which announced that its losses in 1985 exceeded four billion dollars. The *average product liability judgment* in 1985, it says, was \$1.4 million. Shock, fire and mechanical hazards rate high as sources of the suits.

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TECHNOLOGY UPDATE



Offset relative, decibel, and frequency measurements complement the basic measurement functions of Fluke's 8060A 4½-digit DMM. The instrument's conductance range allows you to measure resistance values as high as 10,000 MΩ.

°C or °F; you select the unit of measure via a switch. The measuring capability of these DMMs ranges from -50°C (-58°F) to +1200°C (+2192°F) with a resolution of 1° and an accuracy of $\pm(0.5\%+3^{\circ}\text{C})$ or $\pm(0.5\%+5^{\circ}\text{F})$. Each of the three Philips DMMs in **Table 1** accepts a PRT100 probe and provides a direct readout in °C with 0.1°C resolution between -60 and +200°C, and $\pm 1^{\circ}\text{C}$ accuracy between -20 and +100°C.

DMMs probe logic circuits

If you need to investigate both analog and digital circuitry, consider using a DMM with logic functions, such as the Triplet 4700 and Philips PM2618 and PM2718. The Triplet 4700's logic function has a fixed logic threshold of 1.75V, and it

can detect pulses as short as 60 μsec . The Philips DMMs handle logic signals having logic swings of as much as 100V. By probing the logic's V_{CC} supply and entering this value with the DMM's Zero key, you automatically set the DMM's logic levels to $\leq 0.25 \times V_{\text{CC}}$ for a logic low and $\geq 0.75 \times V_{\text{CC}}$ for a logic high. On power-up, the V_{CC} value defaults to 3.2V, giving you TTL-compatible thresholds of 0.8 and 2.4V.

You can use the PM2618 or PM2718 to probe logic circuitry operating at frequencies as high as 10 MHz. You can tell from the DMMs' displays whether the signal is a square wave or whether it's pulsing high, pulsing low, stuck high, stuck low, stuck at an intermediate logic level, or open-circuit. The two models also include beepers that indicate the signal's logic level and the presence of pulses.

Some DMMs offer an analog-scale indication of measured values, which is useful in trimming circuits for peak or trough responses, or for nulling them to zero. In such applications, it's easier to observe signal trends—whether the signal's rising or falling, and the rate of rise or fall—on an analog scale than on a digital display.

Fluke, Philips, and BBC-Metrawatt/Goerz provide meters that incorporate analog scales in their DMMs' LCDs, although the analog scales from the three companies operate very differently. Fluke's 3¾-digit Model 27 DMM incorporates a linear bar graph that indicates the magnitude of the measured value as a proportion of full scale; each segment of the bar graph is equivalent to 100 digits (3.1% of full scale) on the digital display. Separate indicators at the left end of the bar graph indicate the signal's polarity. Using the bar graph, you can make coarse circuit adjustments to obtain a reading of within 100 digits of the required value; you must resort to the digital display to fine-tune your circuit. The polarity indicators assist you in nulling cir-

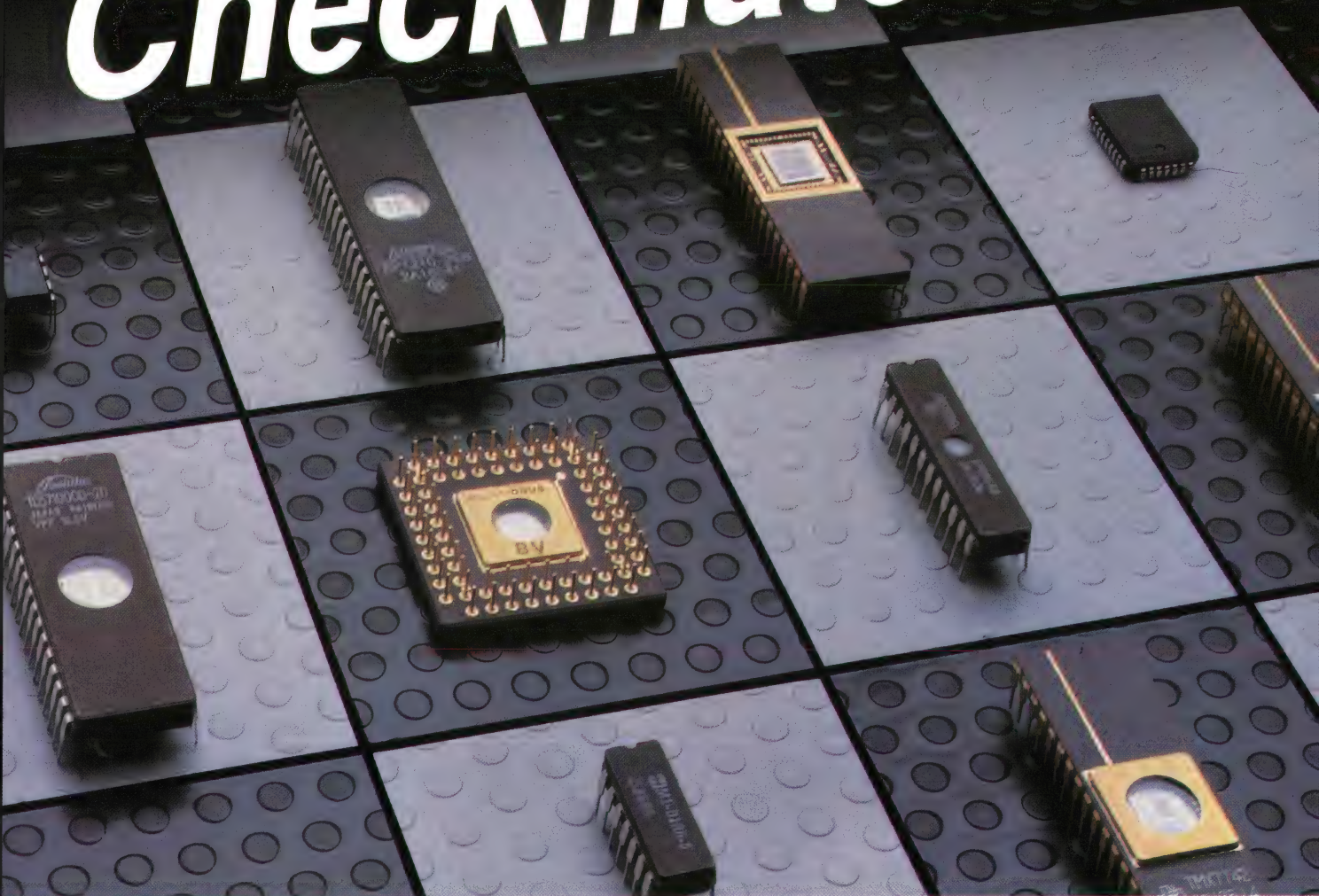


The advanced user features on the 4¾-digit Model 3430 from North American Soar include dBm and relative measurements as well as frequency, temperature, and peak-hold functions.

cuits to zero by pulsing on and off when the input is below 20 digits.

The 4½-digit PM2618 and PM2718 DMMs from Philips feature an entirely different analog bar graph display that's optimized for observing signal trends and for peaking and nulling applications. All segments of the bar graph are normally on, except for two, which form a gap in the display. This gap moves to the right when the input signal increases and to the left when it decreases. The rate at which it moves left or right is inversely proportional to the input signal's rate of change—the slower the input signal's rate of change, the more sensitive the movement of the bar graph becomes. Using this type of analog display, you can quickly tune a circuit close to its peak or trough response, and then slowly fine-tune the circuit to the peak or trough with 8-digit (0.04% of full scale) resolution.

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TECHNOLOGY UPDATE

When you activate the PM2618's or PM2718's relative-measurement function, the analog bar graph becomes a center-zero null detector: It allows you to tune a circuit to zero (by setting the relative-measurement reference to zero) or to any desired value (by setting the relative-measurement reference to that value). The closer you are to the null or required value, the more sensitive the bar graph becomes. You can adjust the circuit to a null or required value with an accuracy of $\pm 0.3\%$ of range.

The analog scale on the M2037 and M2042 from BBC-Metrawatt/Goerz is an LCD simulation of a conventional analog meter, complete with scale markings and a moving needle. On the M2037, the simulated analog meter has a scale length of 88 mm; its 70 scale divisions are calibrated from -5 through zero to +30 to indicate

For more information . . .

For more information on the handheld DMMs described in this article, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

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(040) 783760
Circle No 696

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Triplett Corp
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Bluffton, OH 45817
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Circle No 699

readings between -16.6% of range and +100% of range. For negative signals with magnitudes greater than 16.6% of range, indicators at both ends of the scale reverse the scale's polarity.

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ZIATECH CONTROL:



TECHNOLOGY UPDATE

The simulated analog meter on the M2042 has a scale length of 102 mm. The meter has 60 scale divisions, and it provides automatic scale marking, depending on the range you select. The M2042 is unconventional in that you can expand the scale in eight stages (between $\times 2.5$ and $\times 500$) to obtain an effective scale length of greater than $\pm 10\text{m}$ and ± 7500 scale divisions.

Consider dc-voltage measurements, for instance. When you're not using the DMM's expansion (or zoom) function, the two ends of the scale always indicate plus and minus full range, and the pointer moves between them through a center zero. When you activate the zoom function, 50 of the scale divisions around the pointer's position increase in resolution. In effect, the zoom function lets you increase the sensitivity of the pointer's movement, so you can determine signal

trends more accurately.

Five divisions at each end of the expanded section indicate signal excursions into the remaining portions of the scale (plus and minus full range). In addition, when you activate the DMM's Auto function, the 50-division window on the expanded scale automatically moves with the changing input signal.

Whichever handheld DMM you choose, your instrument will require recalibration at least once a year to maintain its published accuracy specification. Until now, all handheld DMMs have required screwdriver recalibration: In other words, you had to open the case and adjust potentiometers or trimming capacitors. The PM2618 and PM2718 DMMs from Philips, however, employ the digital calibration technique, which has become the norm on high-performance, μP -controlled benchtop DMMs.

The PM2618 and PM2718 store digital calibration constants in triplicate in internal nonvolatile memory, using a majority check on their values to guard against memory corruptions. Without opening their cases, you can recalibrate these DMMs either manually (through the meters' front-panel controls) or automatically (by coupling them to an IEEE-488 controller). The DMMs have 2-wire serial I²C-bus interfaces, so you need a PM9181 interface adapter to make the link to an IEEE-488 system.

Finally, the company's PM2518 also has an I²C-bus interface, so although this DMM still requires recalibration with a screwdriver, you can use an IEEE-488 system to check the calibration. **EDN**

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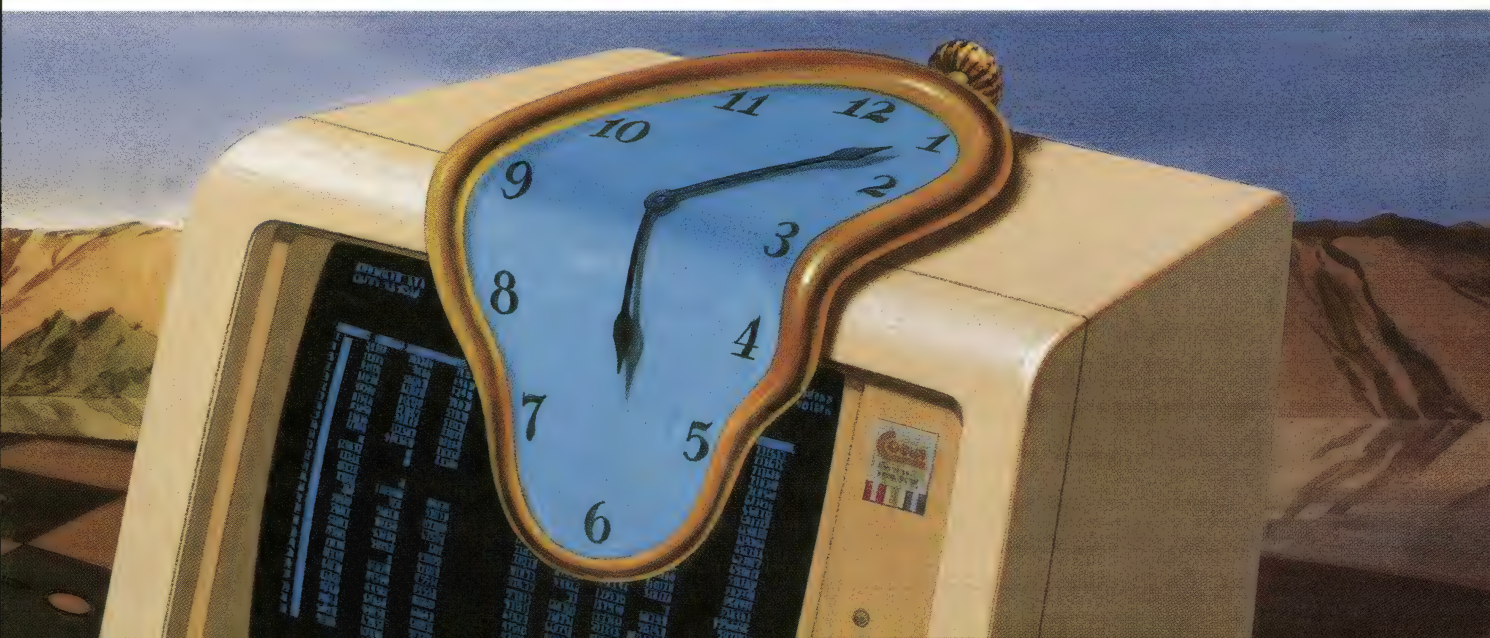
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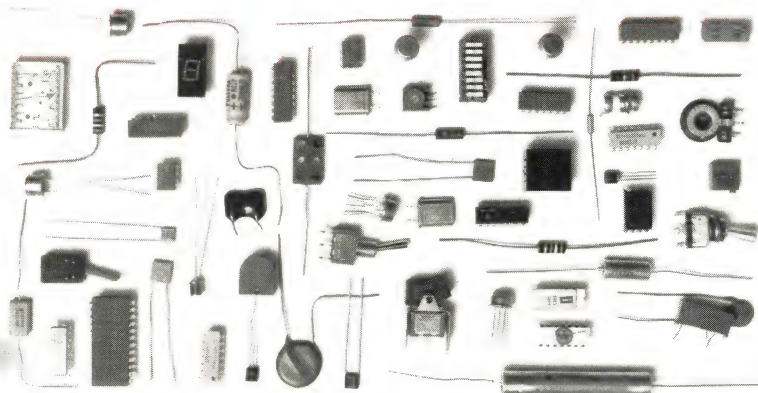
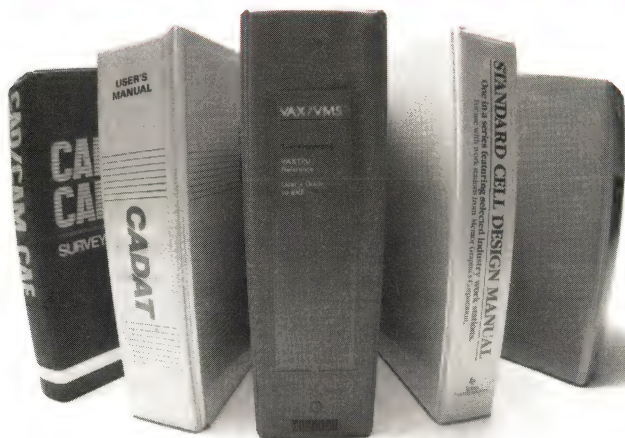
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INTERFERENCE SUPPRESSORS
General Technical Information

The tests described below are those among the tests which are significant for capacitors used as interference suppressors for which national approvals are required.

Standard	Test voltage in type test	Endurance test at +85°C (160°C)
SEN 432901 (IEC 161)	1075 VDC 1 min 1500 VAC 1 min	$1.5 \times U_a$ $1.7 \times U_a$
X-application		
EMKO 11N, D, E1	1075 VDC 1 min 1500 VAC 1 min	$1.5 \times U_a + 1000 \text{ V, } 50 \text{ Hz}$ $0.1 \text{ sec each hour}^*$ $1.7 \times U_a + 1000 \text{ V, } 50 \text{ Hz}$ $0.1 \text{ sec each hour}^*$
Y-application		
SEV	1075 VDC 1 min 9 kV surge** 1500 VAC 1 min 5 kV surge**	$1.5 \times U_a$ $1.7 \times U_a$
X-application		
VDE 0565-1	1075 VDC 1 min (X ₁ , X ₂) 4 kV surge (X ₁)** 1500 VAC 1 min	$1.25 \times U_a + 1000 \text{ V, } 50 \text{ Hz}$ $0.1 \text{ sec each hour}^*$ $1.7 \times U_a + 1000 \text{ V, } 50 \text{ Hz}$ $0.1 \text{ sec each hour}^*$
Y-application		
IEC 65	2000 V 50 Hz 1 min Surge: 50 discharges from 1 nF capacitor charged to 10 kV	$500 \text{ V } 50 \text{ Hz} + 100 \text{ V } 50 \text{ Hz}$ $0.1 \text{ sec each hour}$ 1500 hours^*
	220 or 440 VAC 0.1 sec exposure 220 °	
UL 1414	120 V, 60 Hz + 5 kV surge 50 discharges from 1 nF capacitor charged to 10 kV	
Across-the-line		
Antenna coupling and line-by-pass		

* figure 1
** figure 2

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Capacitors 1986

RIFA
capacitors

INTERFERENCE SUPPRESSORS
General Technical Information

Figure 1: Endurance test
According to IEC 384-14 the capacitor shall be connected to a 220 V resistor during the 1000 V test.
During an IEC 65 test no resistor shall be used.
During 1985, some countries will make decisions of not using any resistor.

Figure 2: Surge voltage test
According to SEV
Up for X cap = 3 kV
Up for Y cap = 5 kV
According to VDE and IEC 384-14
Up for X1 cap = 4 kV

Figure 3: Charge/discharge test
According to VDE 0565-1 the capacitors shall be tested 10000 pulses at 100 V/us and $U/2 \times U_a$ for PHE 800 and PHE 810.
RIFA tests the capacitors with metallized paper as dielectric 10 times the specified values in the article tables: 10000 pulses and X capacitors 630 VDC: IEC 65 and Y capacitors 1000 VDC.

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Advances in flat-panel-display technology improve display features and cut prices

J D Mosley, *Regional Editor*

The R&D dollars that flat-panel-display manufacturers have spent over the past two years are finally bearing fruit: Prices are falling, the displays are more readable thanks to higher resolution and sharper contrast, and a few color displays are now available. In addition, you can order some units according to your custom specifications.

Although CRTs continue to dominate the market for computer monitors, flat-panel displays remain unsurpassed for applications that have power-supply or weight restrictions. Moreover, the flat-panel displays can tolerate electromagnetic interference and wide temperature fluctuations. Furthermore, flat panels can withstand rough treatment that would destroy a CRT.

Manufacturers continue to extend the basic flat-panel technologies—liquid crystal, vacuum fluorescence, electroluminescence, and gas discharge—to produce low-cost and highly readable screens for industrial, military, and portable applications. Each of these display technologies differs from the others in benefits and features.

Flat-panel displays are divisible into two general categories: passive and active displays. Liquid-crystal displays (LCDs) are the only representatives in the passive category, and they are the least expensive kind of flat-panel display. They rely upon reflected ambient light for visibility.

In contrast, active—or emissive—displays generate their own light and serve well in applications that have traditionally employed CRTs. Displays of this type include gas-discharge (ac and dc plasma) units,



Full-color TFT LCDs are currently available from Epson, which uses the displays in its pocket TVs. Each pixel lights a red, blue, or green filter to generate the desired color.

electroluminescent (EL) displays, and vacuum-fluorescent displays (VFDs). Like CRTs, many of these displays can be hard to read in very bright environments or in direct sunlight. Furthermore, each of these active displays emits light in a different color: EL displays produce an amber glow; VFDs offer a blue-green display; and plasma displays emit a red-orange light. Techniques such as filtering and the use of different phosphors can provide alternatives to the standard display hues.

The low cost of LCDs makes them an attractive initial consideration for any design engineer who has chosen to employ a flat-panel display. The fact that LCDs rely upon

reflected ambient light for visibility can either be a boon or a problem: These displays are an excellent choice for viewing in direct sunlight, but it's difficult to read them in low-light situations because the contrast ratio between the pixels and the background decreases as ambient light diminishes. As the size of an LCD increases, the ability to multiplex the driver circuitry reduces that circuitry's cost and complexity, but contrast ratios fall off in multiplexed displays, because a reduction in the voltage differential diminishes the intensity of the display.

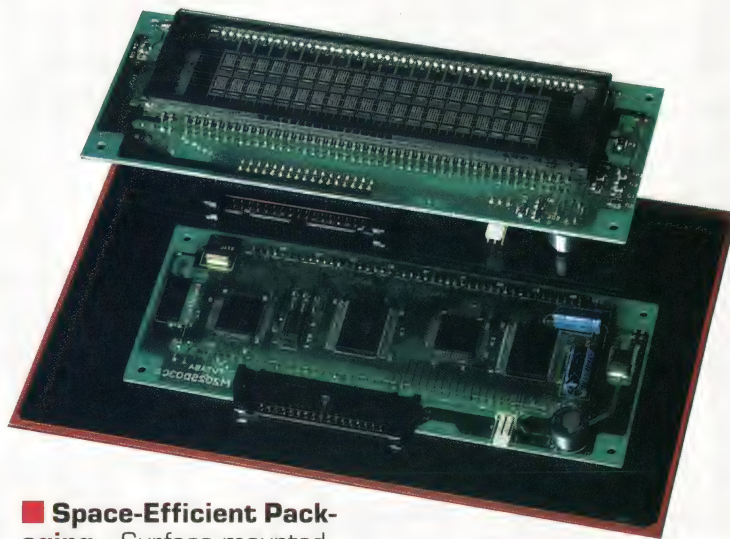
Epson Corp is working on three methods of improving LCD contrast ratios. The first is an active-matrix

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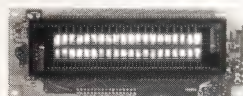
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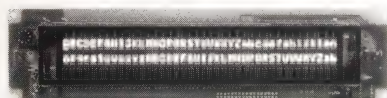
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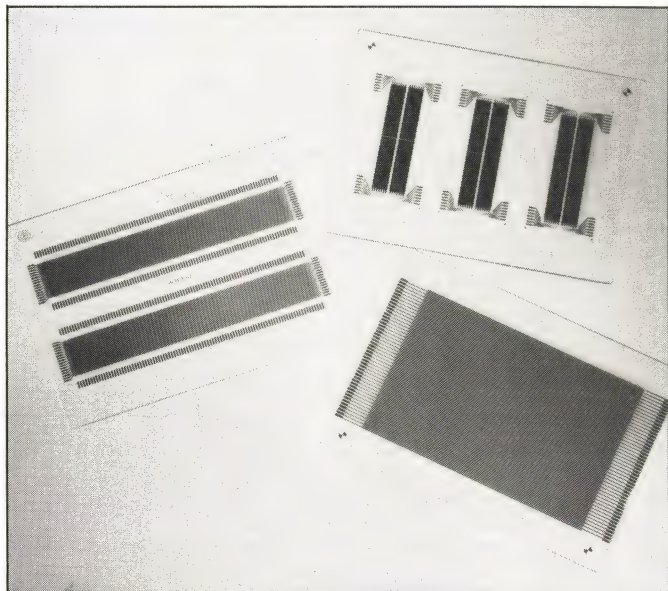


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CIRCLE NO 144

TECHNOLOGY UPDATE



Flexible enough to customize your application-specific active-display designs, the dc EL techniques used to produce Sigmatron Nova's flat-panel displays give you fast turnaround and low NRE charges.

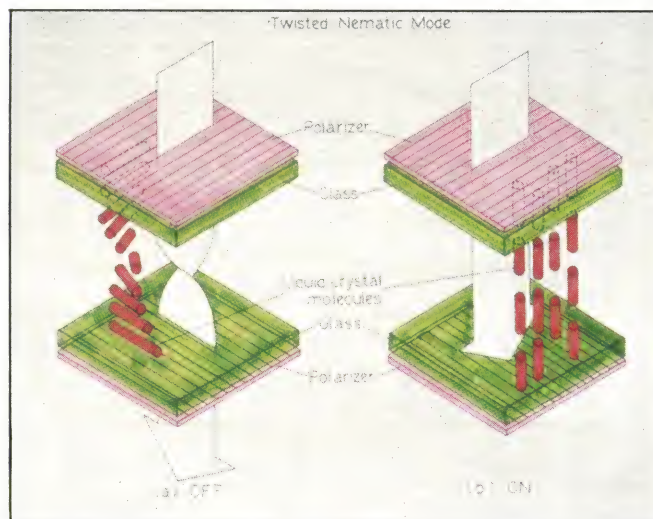


Fig 1—Twisted-nematic LCDs use molecules that act like a valve to increase contrast ratios for brighter, sharper displays. These molecules twist the light 90° so that it can pass through the display's polarizers (a). Upon application of a voltage to the LCD's electrodes, the molecules align themselves, eliminating the twist, and the display's polarizers block the light (b). (Courtesy Epson America Inc)

technique that uses thin-film transistors (TFTs) or metal-insulator-metal (MIM) diodes to control the voltage applied to each pixel. The contrast ratios of the resulting active-matrix multiplexed displays can actually surpass that of a non-multiplexed LCD. With the addition of a fluorescent backlight, the contrast improves even more, although the fluorescent materials currently in use (powdered phosphors) have very short life spans of about 50 hours, and they consume an additional 5W.

TFT-based displays feature 60° viewing angles and an 80-msec response time. Contrast ratios are greater than 10:1, and these displays are well suited to gray scaling. Products based on TFTs are available now, and one member of the family is a full-color TFT LCD. A 5.13-in.-diagonal version of this color display ranges in price from \$3000 to \$7000. TFT LCDs in general are relatively expensive, averaging 2.2 to 2.5 times the cost of reflective twisted-nematic (TN) LCDs that are comparable in size and resolution.

Displays incorporating MIM active matrices are easy to fabricate,

requiring only two or three photo masks and using a sputtering process to deposit the metal film that creates the diodes. The TFT fabrication process involves four photo masks, and each transistor is integrated on the same substrate as the display. Although it's more difficult to manufacture TFT LCDs, the display package is more compact than that of a comparable MIM display, and the switching characteristics of the TFTs provide better image quality. No MIM devices are commercially available as yet.

Twisted light boosts contrast

The second method used by Epson to improve contrast ratios is actually an extension of TN technology, the basis of most of today's LCDs. Standard TN LCDs are composed of positive nematic materials whose molecules are not arranged in distinct layers. The liquid-crystal molecules act like a valve, twisting incoming light 90° so that the light can pass through the display's polarizers (Fig 1). To "turn on" a pixel, a voltage applied to the LCD's electrodes aligns the molecules, eliminating the twist and allowing the polarizers to block the incoming

light. The twist also produces a sharp threshold voltage to prevent pixels from being partially turned on in multiplexed displays.

TN displays have low operating voltages of 3 to 5V and can use inexpensive, low-voltage driver ICs. As little as 0.1 μ W can light a TN LCD pixel, making these displays suitable for battery operation. The low power consumption also gives the crystal material a long life expectancy. A 640×200-pixel, 11-in.-diagonal TN display from Epson costs \$200 to \$300.

By changing the liquid-crystal material, Epson has developed a supertwisted nematic display. Just as a TN display's 90° twist increases the contrast ratio, a supertwist display's 270° light twist further improves the display's readability by more precisely defining the threshold voltage. Like its standard TN counterpart, a 640×200-pixel, 11-in.-diagonal, supertwisted display costs \$200 to \$300. Company officials believe, however, that the 300-msec response time for both supertwisted and standard TN displays is unacceptably slow for high-resolution graphics and animation. Furthermore, fabrication of super-

TECHNOLOGY UPDATE

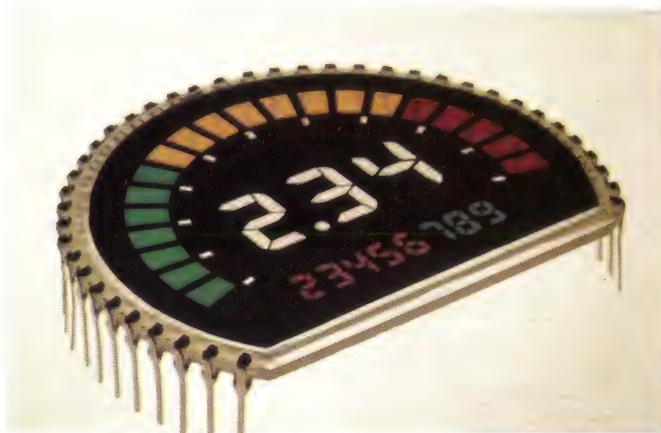


Fig 2—Using dichroic dyes to eliminate the need for polarizing lenses, this LCD from Polytronix makes better use of available light than do traditional LCDs. Note the highly customized shape, coloration, and layout of the display.



A resolution of 83 lpi is the distinctive feature of the EL8358-M from Planar Systems. The EL display boasts graphics capability that rivals the quality delivered by CRT displays.

twisted displays involves an expensive, oblique evaporation process and adherence to very precise physical tolerances.

Epson is developing a third technique, one that uses ferroelectric smectic materials, which are generally referred to as Smectic C. In theory, an electrical field controls the polarization of these crystalline materials, providing significantly improved response times and superior image quality.

Dichroic LCDs dump polarizers

One company, Polytronix, has chosen to eliminate the use of polarizers altogether in some of its devices. By definition, polarization cuts an LCD's light by 50% and limits the viewing angle. Using phase-change dichroic technology, Polytronix employs dyes that look dark on one axis and clear on another, and it mixes them with the liquid-crystal material. The resulting displays are brighter and offer a complete hemispheric viewing field.

Dichroic LCDs are only available as negative-image displays—light characters on a dark field—which may take some getting used to. Furthermore, the gradual threshold curve makes dichroics inappropriate for high-density displays that would require multiplexing. On the plus side, dichroic displays can operate in temperatures ranging from -10

to +90°C, using low-voltage 6V drivers. If you add heaters—to meet the requirements of a military application, for example—the displays can operate at temperatures as low as -55°C, but drive requirements increase to 28V.

Because the company uses a silk-screened photomasking production process, you can order inexpensive, highly customized displays (**Fig 2**). The use of color filters lets you accentuate critical elements of the display. Pricing begins at \$5 for commercial-grade LCDs and at \$25 for military-grade displays with antireflective coating and integrated heaters.

Compared with passive LCD technology, the active technologies—electroluminescence, vacuum fluorescence, and gas discharge—are brighter, but much more costly. EL displays, because they're solid-state devices, offer advantageous environmental characteristics such as good shock resistance and vibration resistance and operation over a wide temperature range. EL displays have the lightest weight of all flat-panel technologies, and they're easily readable either in direct sunlight (depending on the level of multiplexing or power supplied for the application) or in total darkness. Their fast response speed suits them well to multiplexing.

EL panels offer wider viewing

angles, higher contrast, and better resolution than LCDs. However, EL panels consume about 100 times more power than LCDs, require high driving voltages (greater than 150V), and cost twice as much as LCDs. As a result, these displays are better suited to industrial-control and military applications than to portable, battery-powered products.

Army backs EL development

Because of its solid-state nature, an ac thin-film EL (TFEL) display is extremely rugged and reliable. TFEL displays with MIL-spec driver ICs hold up at elevations greater than 400,000 ft and withstand pressure greater than six atmospheres, shocks of 100g, and temperatures ranging from -55 to +85°C. Degradation of luminance is less than 0.3%/°C between 0 and 100°C. Commercial suppliers report MTBF figures in excess of 30,000 hours. These factors have led the Army's Electronic Research and Development Command (ERADCOM) to concentrate its efforts and resources on boosting TFEL display development, through funding of private research and development and by rigorous testing of purchased parts.

Planar, a major manufacturer of ac TFEL displays, makes a 320×240-pixel, 2-color EL monitor

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TECHNOLOGY UPDATE



The characteristic gray-scale capabilities of fully populated VFDs are evident in this 320×240-pixel graphics display from Futaba.



A 4-ft² display in a cabinet that's only 8 in. deep, Lucitron's Model 34V-131 uses electrons from dc plasma gas to excite phosphors.

for the US Army. The display has a 4×5-in. active-matrix area that produces red, green, yellow, and black display images. Commercial availability of this display isn't expected until the late 1980s. However, Planar offers a selection of standard TFEL displays featuring a range of resolutions starting at 320×128 pixels. One notable model is the EL8358-M, a 640×200-pixel EL display with a resolution of 83 lpi. This 1-lb, 0.55-in.-wide display is designed specifically for MS-DOS laptop computers. It costs \$775 in OEM quantities.

AC thin film is only one technology being pursued by EL manufacturers. Sigmatron Nova, supplier of a range of TFEL displays, has of late focused its design activities on dc EL technology, which makes use of powdered phosphors. This technology readily lends itself to application-specific display designs and sizes; use of a mask process, instead of the more expensive fixture method required in the manufacture of TFEL displays, lets the company accept small-lot orders that would otherwise be too costly to produce. Typical nonrecurring engineering (NRE) costs range from \$10,000 to \$20,000 for a 3×5-in. active-area display. Production costs vary with size and volume.

Cherry Electrical Products is another company that's building dc EL displays. With its 640×200-pixel unit, scheduled for introduction this fall, the company believes it has solved the problem of the short life expectancy of the dc EL phosphor materials. According to the company, estimated brilliance degradation

in its new flat-panel displays is less than 30% after 10,000 hours.

Cherry also expects dc EL technology to result in high yields and low production costs. The fabrication of dc EL panels requires only one thin-film evaporation and fewer critical steps than the fabrication of ac EL panels. AC EL panels require

For more information . . .

For more information on the flat-panel displays described in this article, contact the following manufacturers directly or circle the appropriate number on the Information Retrieval Service card.

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TECHNOLOGY UPDATE

TABLE 1—PRICE/PERFORMANCE COMPARISON OF TECHNOLOGIES FOR A MULTIPLEXED, 2000-CHARACTER DISPLAY

TECHNOLOGY	VIEWING AREA (IN.)	RESOLUTION (PIXELS)	RESOLUTION (LPI)	BRIGHTNESS (fL)	CONTRAST	VIEWING ANGLE	POWER (W)	PRICE (1000)
TN LCD	3.5 × 10	640 × 200	60	VARIES WIDELY	4:1	25°	0.2	\$150 to \$175
EL	3.8 × 7.7	512 × 256	67	23 TO 30	10:1	140°	13 TO 15	\$500 TO \$600
PLASMA	4 × 8	512 × 256	60	25 TO 30	20:1	120°	25 TO 35	\$450 TO \$500
VFD	3.8 × 5	320 × 240	63.5	60 TO 100	60:1	120°	15 TO 40	\$540
MONOCHROME CRT	7 × 9.5	640 × 480	100 TO 1000	200	10:1 TO 100:1	140°	70 TO 200	\$100 TO \$125

(SOURCE: EPSON AMERICA INC)

several sputtering steps and are substantially more expensive to build. Cherry currently offers only segmented alphanumeric, numeric, and bar-graph EL displays, with prices ranging from \$12.75 to \$61.85 (500).

Vacuum fluorescence is the flat-panel technology that offers the highest display contrast and brightness characteristics. As is evident from **Table 1**, VFDs can produce images that rival those generated by a CRT's display, at a fraction of the power consumption. Often, a single 5V dc power supply and less than 1A are all you need to energize these panels. Accordingly, the driver ICs for these low-power displays are inexpensive as well, bringing further reductions in your integration costs. VFDs emit a blue-green light that's exceptionally bright and has a broad wavelength; consequently, they're amenable to the filtering used to produce color displays. Like other active flat-panel technologies, however, VFDs are significantly more expensive than either CRTs or LCDs.

Futaba, a major manufacturer of VFDs, builds graphics VFD modules that include the necessary support electronics to reduce your system development and integration time. An example is the \$540 (1000) GP1002B03A 320×240-pixel graphics display, which comes with driv-

ers, a controller board, and a dc/dc converter: This VFD specs a brightness of 60 fL and weighs 2.86 lbs. The display operates from 5 and 12V supply voltages. The dot pitch is 0.375 mm, and the dot size is 0.3×0.3 mm. The unit can withstand 4g vibrations and 40g shocks, and it operates over 0 to 50°C. The GP1002B03A adapts easily to a CRT-controller output. Futaba also sells a 128×64-pixel graphics module, the GP1005A01A, which specs a 400-fL brightness level and costs \$305 (1000).

Plasma has the big picture

In the never-ending effort to make larger flat-panel displays, ac plasma gas-discharge displays appear to have taken the lead. Photonics Technology has produced an ac plasma display with a diagonal measurement of 1.5m—almost 5 ft—and comprising a matrix of 2048×2048 pixels. Developed under military contract, the Photonics display is merely a predecessor to a 4096×4096-pixel display with a 3m-diagonal measurement. Another manufacturer, Norden Systems, is working on a panel that will incorporate more than one million pixels.

The reason ac plasma is so well suited to big-screen applications is that the gas's inherent memory characteristics eliminate any need for continuous screen refreshing—a

monumental task in a large screen. In addition, plasma gas-discharge displays produce bright images while consuming one-quarter of the power required by a CRT display of similar size.

AC plasma is not the only technology being employed in large displays, however. One company, Lucitron, has developed a 35-in.-diagonal display that uses dc plasma gas as an electron source to excite phosphors—a process that imitates CRT operation, but yields a display that fits in a case that is 8 in. deep. Although the product was developed under the auspices of the US Naval Ocean Systems Center, the company offers this 4-ft², 256×352-pixel display to commercial customers as the \$45,000 Model 34V-131.

Also in the dc plasma category, but on a smaller scale, is a 640×400-pixel display from Dixy Corp. The unit costs ¥250,000 (approximately \$1000). You can choose from among the 9-in. DO640SB, the 10-in. DO640LB, or the 12-in. DO640AB. Featuring a horizontal viewing angle of 115° and a vertical viewing angle of 140°, the products provide a full CRT interface and include all the required drive electronics. **EDN**

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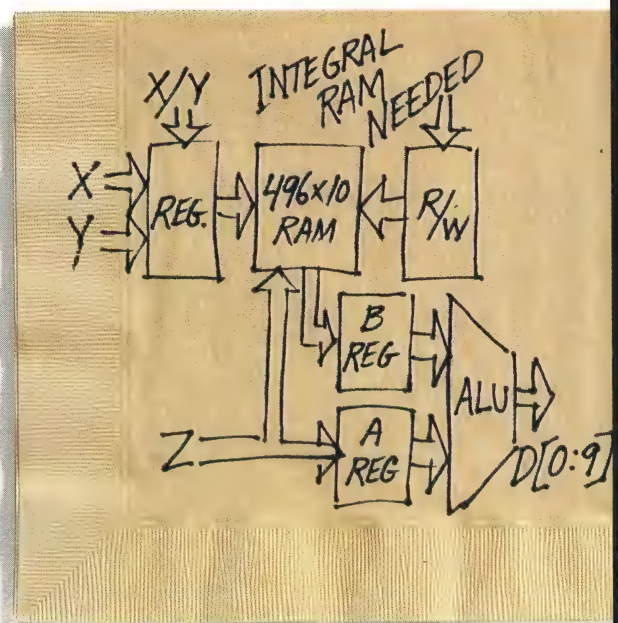
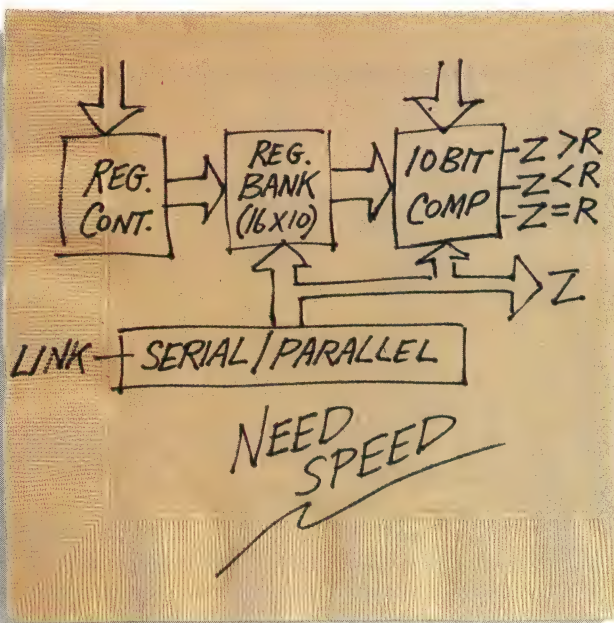
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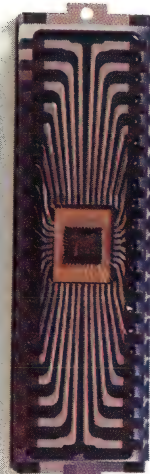
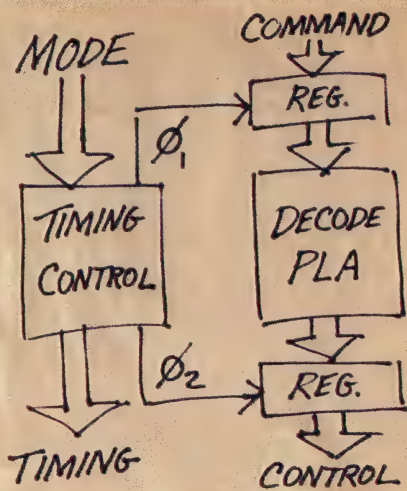
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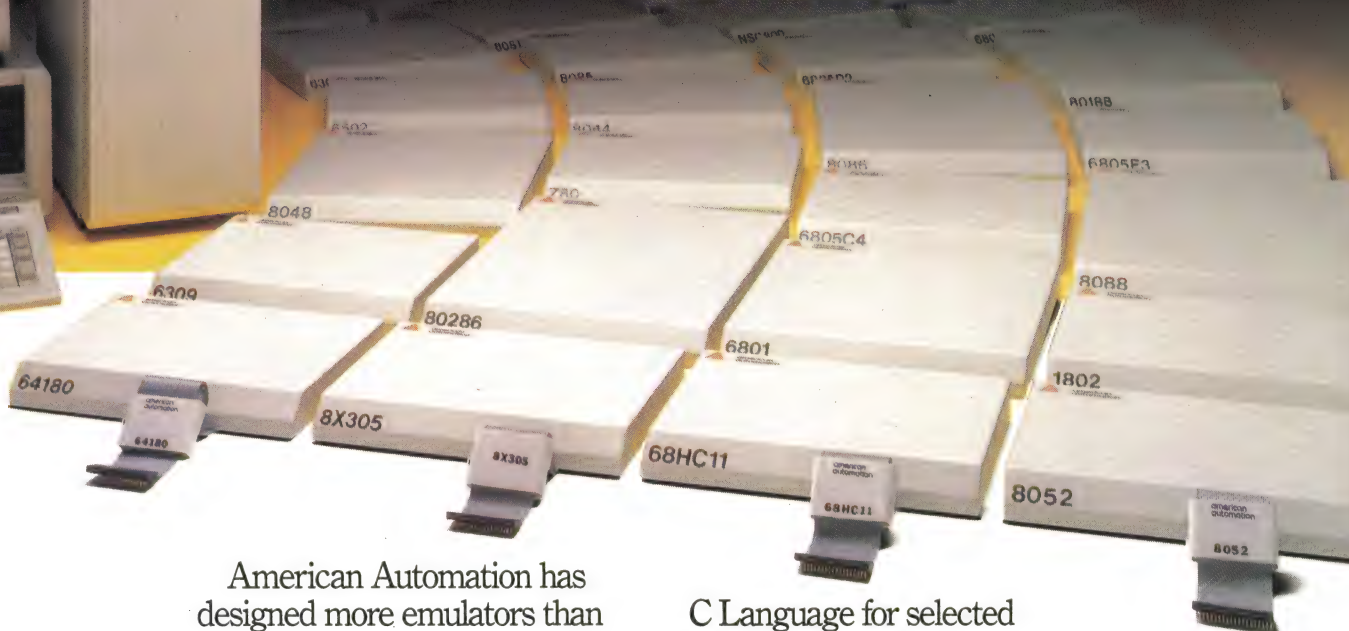
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ADEE East '86 sessions, courses, workshops stress practical CAD/CAE applications

Steven H Leibson,
Regional Editor

This year's Automated Design and Engineering for Electronics conference—ADEE East '86—takes place at the World Trade Center on Commonwealth Pier in Boston from September 30 through October 2 and emphasizes the practical aspects of today's CAE and CAD systems. Fifteen sessions, two full-day short courses, two 3-hour tutorial workshops, and two panel discussions offer you the opportunity to learn how to efficiently select, acquire, and use CAD and CAE systems to design ICs, pc boards, and electronic systems. In addition, more than 60 exhibitors will display CAD/CAE tools and products.

Five tracks guide you

To help you decide which events to attend, show organizers have grouped the programs according to five tracks: investigation and acquisition, circuit/system implementation, circuit verification, designing for manufacturability, and system administration. If you're just starting to consider and evaluate CAD and CAE systems, you might be interested in the investigation and acquisition track; it's designed to aid initial planning. This track includes three sessions, the two dialogue panels, and one workshop.

The sessions are entitled "Methods for acquiring CAE/CAD systems" **session 4**, "Issues in CAE hardware selection" **session 10**, and "Integrating the elements of a PC-based engineering workstation for CAE/CAD" **session 15**.

"Methods for acquiring CAE/CAD systems" will show you how to assess your CAD/CAE needs and

present options for obtaining and financing a system. This program will present four papers: "Evaluating the need for a CAE system," "How to justify CAE equipment considering the tax law changes," "The advantages of renting and leasing," and "Investigating used CAD/CAE equipment." Speakers from Valid Logic Systems, Future-Net, Orion Instruments, and Daisy Systems, in "Issues in CAE hard-

ware selection," will read papers that will help you review your hardware choices, which may range from PC-based systems to mainframes. "Integrating the elements of a PC-based engineering workstation" will explore the limits of CAE products available for use on low-cost personal computers.

In the investigation and acquisition track's workshop, Leonard Marks, director of mechanical engi-

ADEE EAST '86 PROGRAM SCHEDULE

TUESDAY, SEPTEMBER 30, 9:00 AM

SESSION 1—APPLICATION-SPECIFIC HARDWARE VS GENERAL-PURPOSE ACCELERATORS FOR DESIGN VERIFICATION

SESSION 2—DATABASE APPLICATIONS FOR CAE/CAD

SESSION 3—DESIGNING FOR MANUFACTURABILITY WITH PCB/CAD

SHORT COURSE 1—PERSPECTIVE ON CAD/CAM/CAE AND CIM: STRATEGIES, CRITICAL ISSUES, AND LATEST DEVELOPMENTS

SHORT COURSE 2—VLSI GATE-ARRAY DESIGN TECHNOLOGY

TUESDAY, SEPTEMBER 30, 1:00 PM

SESSION 4—METHODS FOR ACQUIRING CAE/CAD SYSTEMS

SESSION 5—ADVANCED ANALYSIS TECHNIQUES FOR ANALOG-CIRCUIT DESIGN

SESSION 6—DOCUMENTATION AND TECHNICAL PUBLICATION IN THE CAE ENVIRONMENT

TUESDAY, SEPTEMBER 30, 4:15 PM

DIALOG PANEL 1—THE CHALLENGE OF DESIGN AUTOMATION: WHAT USERS WANT FROM VENDORS

WEDNESDAY, OCTOBER 1, 9:00 AM

SESSION 7—DESIGN-INTERFACE STANDARDS: FACT OR FICTION?

SESSION 8—ASSESSING THE NEED FOR AND PRACTICALITY OF FAULT SIMULATION

SESSION 9—DESIGN TOOLS FOR CONTROLLING ELECTRICAL PERFORMANCE OF HIGH-DENSITY PRINTED-CIRCUIT BOARDS

WORKSHOP 1—CAE/CAD SYSTEM SELECTION, ACQUISITION, AND UTILIZATION

WEDNESDAY, OCTOBER 1, 1:00 PM

SESSION 10—ISSUES IN CAE HARDWARE SELECTION

SESSION 11—A CRAFTSMAN'S GUIDE TO VLSI DESIGN STYLES AND TOOLS

SESSION 12—OPEN ARCHITECTURE FOR CAE TOOLS

WORKSHOP 2—COMPUTERIZED METHODOLOGIES FOR PRINTED-CIRCUIT-BOARD DESIGN

WEDNESDAY, OCTOBER 1, 4:15 PM

DIALOG PANEL 2—ACHIEVING AUTOMATED DESIGN: VENDORS RESPOND

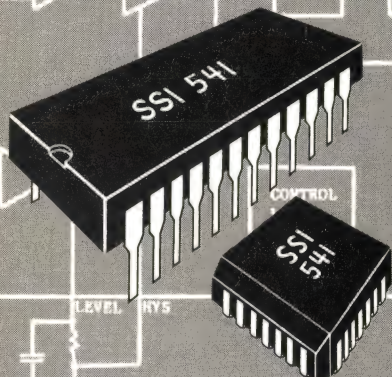
THURSDAY, OCTOBER 2, 9:00 AM

SESSION 13—ELIMINATING THE ROADBLOCKS TO TESTABILITY

SESSION 14—COMPUTER NETWORKING FOR DESIGN-AUTOMATION SUPPORT

SESSION 15—INTEGRATING THE ELEMENTS OF A PC-BASED ENGINEERING WORKSTATION FOR CAE/CAD

NEW HIGH PERFORMANCE READ DATA PROCESSOR DISK DRIVE CHIP



FEATURES:

- MFM & RLL compatible
- Data rates of up to 15Mbits/sec
- Amplitude and time pulse qualification
- High performance, wide dynamic range AGC amplifier
- AGC hold for embedded servo applications
- Dual mode AGC attack rate
- Adjustable attack/decay time
- Feed forward hysteresis control
- R/W mode control for fast write to read recovery
- 24 pin PDIP and 28 pin PLCC

Designed for use with high performance Winchester disk drives, the SSI 541 Read Data Processor IC performs amplitude and time pulse qualification for MFM and RLL encoded systems with data rates of up to 15Mbits/sec. The 541 contains a high-performance wide dynamic range AGC amplifier, a dual rate AGC charge pump, an active differentiator, an adjustable hysteresis comparator, a feed forward hysteresis level control circuit, and a gating circuit with output pulse width control. Individual Amplitude and Time Channel input ports are provided for increased flexibility.

The 541 was developed in an advanced bipolar process with balanced circuitry in order to minimize bit jitter. It operates from +5V, +12V power supplies, and it is priced under \$10 in OEM production quantities.

For more information, contact: **Silicon Systems**, 14351 Myford Road., Tustin, CA 92680. (714) 731-7110, Ext. 575.

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TECHNOLOGY UPDATE

neering at Northrop's Defense Systems Div, will teach "CAE/CAD system selection, acquisition, and utilization." At this workshop, you'll be able to obtain specific information about CAD/CAE system hardware and software availability, limitations, selection, installation, training, and system management.

CAD and CAE users will staff one of the dialogue panels; vendors will chair the other. In the first dialogue panel, "The challenge of design automation: What users want from vendors," several CAD/CAE users will present problems they encountered using their design-automation systems, as well as present needs currently unfulfilled by their systems. The next afternoon at the second dialogue panel, "Achieving automated design: Vendors respond," manufacturers of CAD/CAE systems will address the problems voiced by members of the first panel.

Craft VLSI designs

The single session in the circuit/system-implementation track is "A craftsman's guide to VLSI design styles and tools." **Session 11** will contain two case studies: Ken Karakotosios from Silicon Compilers Inc will present "Designing a parallel-processor communication controller using silicon compilation," and William C Pearson from IBM's General Technology Div will present "Hybrid gate array—a case study." In addition, three other speakers will address the general problems of timing verification, placement and routing algorithms, and automatic layout.

The track's short course, "VLSI gate-array design technology," serves as an introduction to gate arrays; the workshop, "Computerized methodologies for printed-circuit-board design," assumes that you have purchased a printed-circuit design system and leads you through the process of turning that system into a productive resource through training, part and symbol

standardization, and system management.

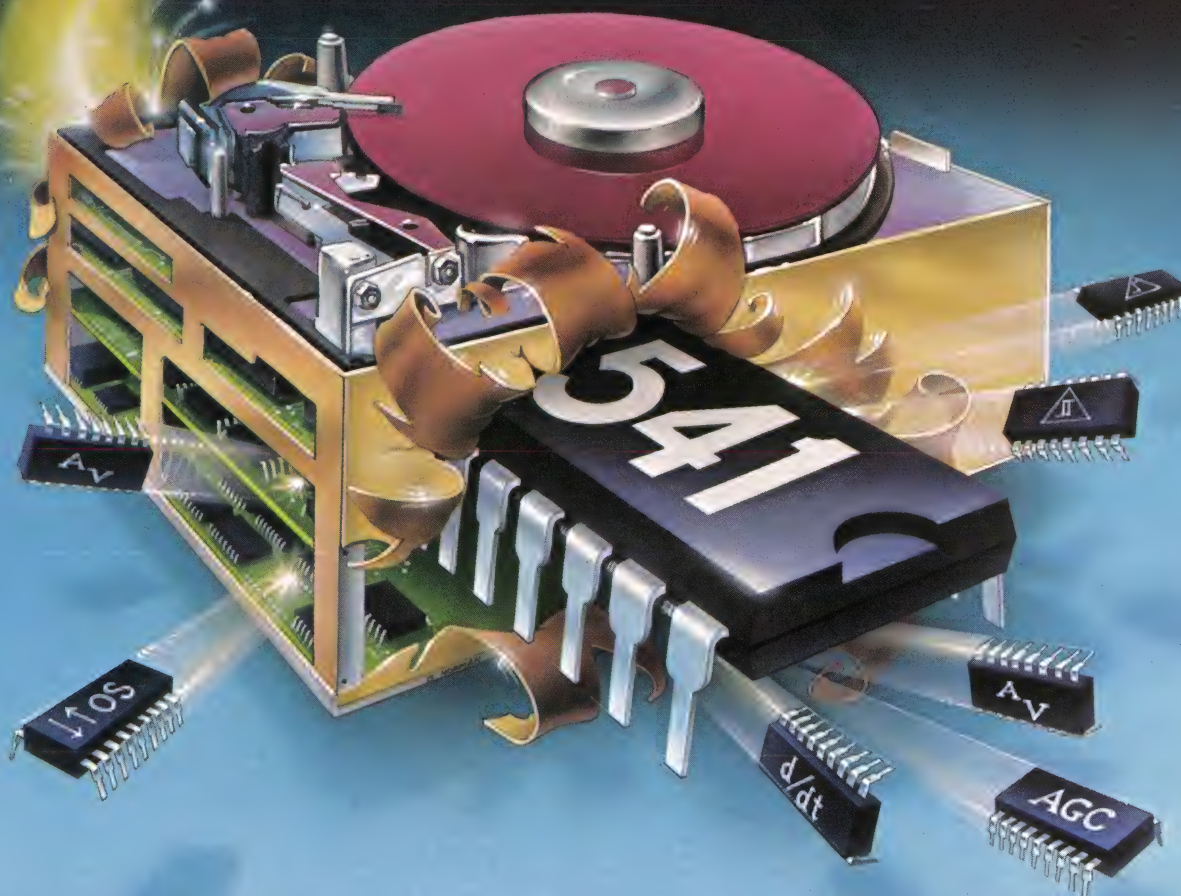
The circuit-verification track includes four sessions, three of which involve surveying available techniques for logic and fault simulation. **Session 1** is entitled "Application-specific hardware vs general-purpose accelerators for design verification"; **session 5** is designated "Advanced analysis techniques for analog circuit design"; and **session 8** is named "Assessing the need for and practicality of fault simulation."

Speakers at **session 1** will debate the relative merits of application-specific hardware accelerators, which increase the performance of one specific task (such as simulation) by one or two orders of magnitude, vs general-purpose accelerators, which speed several tasks but offer less improvement in performance for each task. **Session 5** will explore the capabilities of current analog simulators; six speakers will present papers on analog models, their accuracies, and optimizations. You'll also hear case studies about models for a current-mode converter, a resonant power converter, and a 2N3906 transistor. If you want information on fault simulation, consider **session 8**. It starts with a presentation by Andy Rappaport from the Technology Research Group on "Why fault simulation is more important than most designers think."

A fourth session in the circuit-verification track, "Eliminating the roadblocks to testability" (**session 13**), will help you identify circuit testability problems, show you how to design circuits for testability, and advise how to link your automated design tools to test systems.

The designing-for-manufacturability track is new this year for ADEE East and includes two sessions. **Session 3**, "Designing for manufacturability with PCB/CAD," will highlight the pc-board designer's ability to affect a circuit board's manufacturability. Speakers will address automated board design

SILICON SYSTEMS' NEW READ DATA PROCESSOR CHIP BREAKS THE PRICE/PERFORMANCE BARRIER



MFM and RLL Capability at Data Rates up to 15 Mbits/sec

Now Silicon Systems introduces the SSI 541—the industry's most advanced Read Data Processor chip for high performance disk drive applications. Its high level integration allows it to perform both amplitude and time pulse qualification for MFM and RLL encoded systems—and do it all at data rates up to 15 megabits per second.

Complete Integration of High Performance Functions

Packed inside of the 541 are all these high performance functions: a wide dynamic range AGC amplifier, a dual rate AGC charge pump, an active differentiator, an adjustable hysteresis comparator, a feed-

forward hysteresis control circuit, and a gating circuit with output width control. By utilizing amplitude and time pulse qualification, the 541 is able to gate out shouldering induced noise errors in a high resolution disk drive system.

Costs Less to Buy, Less to Apply—Reducing the User's Part-Count and Size

The 541's complete integration of the read data processor functions cuts down on the user's part-count and manufacturing costs, while boosting reliability and saving real estate. Even with its high performance and cost-saving benefits, the 541 costs less when you buy it and far less when you apply it.

The SSI 541 is designed for application in high performance MFM and RLL encoded

disk drives, disk drives that utilize plated media or thin film heads, and disk drives that offer advanced interface standards.

Price and Availability

Silicon Systems also offers a very low cost sister chip to the 541. It is the SSI 540 with a time domain filter that makes it an optimum solution for low cost, low resolution systems. Both devices are available in production volumes now. In OEM production quantities, the SSI 541 is priced under \$10, and the SSI 540 is priced under \$5.

For complete product information, call us now, or send for more information.

Silicon Systems, 14351 Myford Road, Tustin, CA 92680. (714) 731-7110, Ext. 575.

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and manufacturability guidelines for CAD systems as well as the impact of high-density VLSI on pc-board design and the use of CAD plus CIM to create manufacturable designs.

Session 9, "Design tools for controlling electrical performance of high-density printed-circuit boards," will offer six speakers and papers on tools for ECL circuits, high-speed VLSI designs, and board-level interconnection schemes. You'll also hear how to control your board's electrical performance through design and manufacturing tolerances, laser photo-plotting, and board-level simulation.

The system-administration track is designed to help you keep the CAD and CAE tools you already have or will soon acquire efficient and productive resources. S H Chasen, a senior consultant at Lockheed, will teach the short course "Perspective on CAM, CAD, CAE,

and CIM: Strategies, critical issues, and latest developments." Chasen will focus on strategies for managers responsible for integrating automated design and manufacturing tools into their organizations.

The five sessions in this track are **session 2**, "Database applications for CAE/CAD"; **session 6**, "Documentation and technical publication in the CAE environment"; **session 7**, "Design interface standards: Fact or fiction?"; **session 12**, "Open architecture for CAE tools"; and **session 14**, "Computer networking for design-automation support."

Determine status of standards

"Design interface standards: Fact or fiction?" will include three presentations by representatives of the IPC, IGES, and EDIF electronics-design standards committees, followed by speakers who will offer users' perspectives on the three standards. At "Open architecture

for CAE systems," Roberta Gray from Sun Microsystems, the company that originated the NFS open-architecture file system, will speak on "Open systems: Standards and strategies." Also, Harley Horsager from Zycad will present a paper on "Hardware accelerator open architecture."

Session 14 will include case histories of networking experiences at Honeywell, Sperry, and Gould, as well as tutorial papers on increasing productivity through networked engineering design systems and multi-vendor networks.

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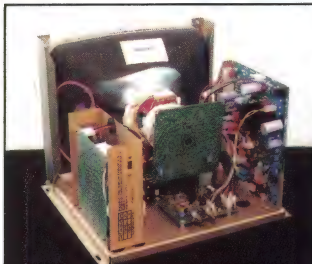
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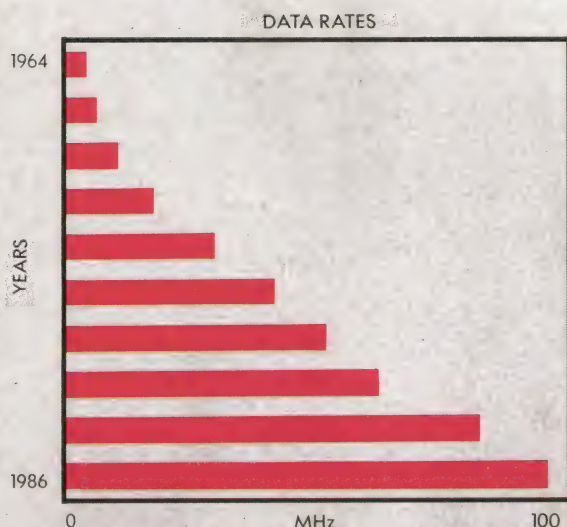
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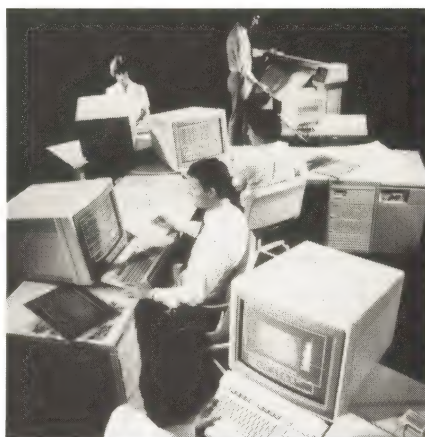
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ADEE EAST '86 PRODUCTS

Family of software packages and computers addresses many engineering design problems

The Design Center is a collection of software programs running on HP 9000 Series 200, 300, and 500 workstations and the HP Series 9000 Model 840 superminicomputer. The programs are suitable for analog- and digital-circuit schematic capture and simulation, pc-board design, microprocessor software development and debugging, mechanical design, and document preparation.

The \$12,000 Model 74210 design-capture program supports schematic capture for analog and digital designs. You can also run a version of the design-capture system on the HP Vectra personal computer and the IBM PC/AT. The system gene-



rates a database and net list, which the Model 74230S digital-design verification system (Hilo-3 simulator based) can use, or which the Model 74610A Analog Workbench

(Spice 3 based) can use for simulating analog designs. Model 74230S costs \$18,000; Model 74610A costs \$14,500.

Once your design is captured and simulated, you can design pc boards on the Model 74400 printed-circuit design system program; it includes an automated router and costs \$60,000 to \$82,000, depending on which workstation and options you select. Other Design Center packages include interfaces to the 64000-UX development system and 3065T board-test system.

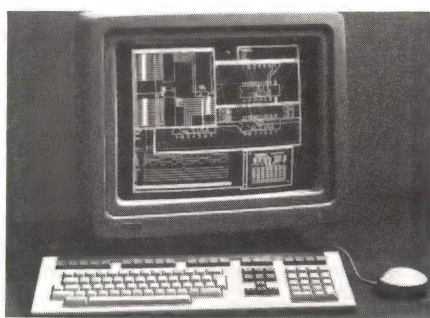
Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 676

CAE software for IC and pc-board designs runs on variety of computer platforms

You can design both integrated circuits and pc boards with this line of CAE software programs, which runs on the IBM PC, MicroVAX, and VAX computers. The software tools include modules for schematic capture, hardware compilation, net-list postprocessing, timing verification, and logic simulation, as well as pc-board design, automatic routing, design-rule checking, and technical-document preparation.

The core \$5200 CT2000 CAE design system for the IBM PC computer family includes a structured graphics editor for schematic capture and other graphics, a Scald-based hardware compiler, a net-list postprocessor, a firmware compiler for defining ROMs, a hard-copy postprocessor for plotting, and a standard component library. Simi-



lar packages for the MicroVAX and VAX computers are the \$11,900 CT4000 and \$12,500 CT10000, respectively.

You can use a Tektronix 4100 Series graphics terminal on the CT10000 or purchase the company's \$2500 G Term/E Term graphics-terminal emulator for the IBM PC, which operates with both the VAX and MicroVAX computers. Additional modules for the CT2000 in-

clude a \$3500 CT2600 Scald-based timing verifier and a \$4250 Cadat-based simulator. MicroVAX versions of the timing verifier and simulator cost \$7500 and \$22,000, respectively. A VAX version of the timing verifier costs \$12,500, and VAX versions of the simulator range from \$50,000 to \$100,000, depending on which model VAX you have.

A \$4250 CT2400 pc-board-layout system for the IBM PC includes automatic-placement and packaging modules. Two auxiliary modules for the CT2400 are the \$500 design-rule checker and the \$5500 CT2500 automated router.

Case Technology Inc, 633 Menlo Ave, Suite 250, Menlo Park, CA 94025. Phone (415) 322-4057.

Circle No 677

How to convert any VAX™ computer into a powerful design and test system.

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Either way, the right buttons to push are 800/547-1512 (in Oregon, 800/542-1877). Or write Tektronix, CAE Systems Division, 5302 Betsy Ross Drive, Santa Clara, CA 95052.

Push a button.



Low-cost CAE software package for IBM PC handles schematics, pc design, simulation

The \$975 EE Designer CAE software package runs on IBM PC and compatible computers and supports schematic capture, circuit simulation, pc-board layout, and artwork generation. The program runs with the IBM color-graphics adapter, the IBM enhanced-graphics adapter, or the Tecmar graphics master, as well as a range of graphic-input devices, including several mice and graphics tablets. In addition, it supports hard copy on Houston Instrument, HP, Roland, Calcomp, and Hitachi plotters and several dot-matrix printers. You need a minimum of 512k bytes of RAM to run the software (640k bytes for systems that use the EGA display adapter).

The program's schematic drafter provides automatic packaging of



gates, pin numbering, and package reference numbering. Its parts library contains more than 200 components; however, you can add additional components. Its interactive simulator uses the schematic graphics and produces waveform or word displays of the nodes you select. The simulator checks for circuit stability, identifies spikes, and can simulate memory components in addition to logic parts.

The layout package supports the following: 36 layers; eight trace widths from 8 to 100 mils; automatic component placement based on physical package size and routelength minimization; automatic design-rule checking for trace-to-trace, trace-to-pad, and pad-to-pad clearances; and pc-board designs as large as 24 in. square. You can use the artwork generator to create Gerber photoplot files, board plots, drill plots, and drill tapes. A report generator produces component parts and price lists and bills of materials for completed board designs.

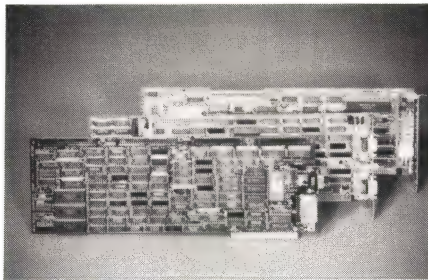
Visionics Corp, 1284 Geneva Drive, Sunnyvale, CA 94089. Phone (408) 745-1551.

Circle No 679

Hardware accelerator and graphics card turns IBM PC/AT into a 32-bit workstation

Using the 3-board GraFlex Co-computer, you can add a 32-bit μ P, floating-point processor, and 1152 $\times$ 800-pixel color graphics to the IBM PC/AT. The board set incorporates a 12-MHz 68020 μ P, a 68881 floating-point coprocessor, 512k bytes of program memory, a Hitachi 63484 advanced CRT controller, and 1M byte of video-RAM display memory. The display section emulates both the IBM color-graphics and professional-graphics display adapters so that existing programs that use either of these display boards are compatible.

The GraFlex includes an Alcyon C compiler, linker, symbolic debugger, relocating loader, and five pro-



gram libraries: standard C routines, graphics, floating point, GSS CGI, and IBM professional-graphics adapter emulation. The floating-point library includes routines for IEEE floating-point math (both with and without the 68881 math coprocessor) as well as Motorola's routines for fast floating-point math.

The 3-board set's program memory is limited to 2M bytes, but you can add extra 4M-byte memory boards to increase the program memory to a maximum of 32M bytes; additions cost about \$400 per 512k bytes. You can also add video RAMs to the display board to achieve a maximum resolution of 1272 $\times$ 824 pixels with 8 bits/pixel, and if you gang four display boards together, you achieve a 4096 $\times$ 4096-pixel display with 4 bits/pixel or a 1448 $\times$ 1448-pixel display with 32 bits/pixel. \$2500.

New Media Graphics, 279 Cambridge St, Burlington, MA 01803. Phone (617) 272-8844.

Circle No 678

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CIRCLE NO 16

ADEE EAST '86 PRODUCTS



μCODE DEVELOPMENT

With the DS3700 Emulzyzer, you can develop code for high-speed, micro-programmable processors. The product uses 10-nsec ECL RAMs to create a writeable-control-store emulation memory with a guaranteed 25-nsec access time to the target system. It also includes a performance monitor and a 35-MHz logic/state analyzer. You control the DS3700 through its RS-232C host interface; software support for VAX and IBM PC hosts is available from the manufacturer.

The writeable-control-store memory supports word widths to 512 bits in 16-bit increments and depths of 1k to 64k words. You can configure the logic-analyzer section with 256 channels and either a 4k- or 16k-word trace memory. The analyzer accepts clocks from five sources, and it supports 16 trigger levels; each level accepts four independent trigger conditions. Prices start at \$12,000.

**Hilevel Technology, Inc., 18902
Bardeen, Irvine, CA 92715. Phone
(714) 752-5215.**

Circle No 682

CAE SOFTWARE

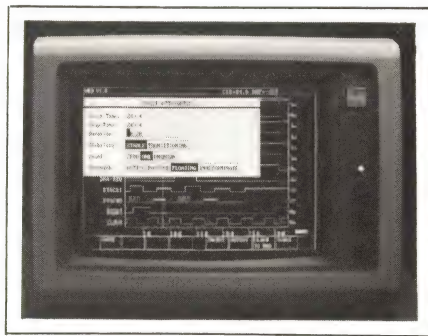
The Workview Series adds CAE functions to the IBM PC and compatible computers. Workview 100 includes hierarchical schematic entry, waveform processing for analyzing simulations, symbol libraries, a document processor that mixes text and graphics, and electronic-mail capabilities with file-transfer utilities for linking to other CAD and CAE systems. Workview 300 is a digital design package that adds

an interactive logic simulator and an optional fault grader to the Workview 100 functions. Workview 500 is suited for analog designers; it includes Workview 100 features plus an analog simulator and parts library. Workview 700 provides you with all of the functions in the Workview 100, 300, and 500 packages.

All versions support a bidirectional EDIF interface format for net lists, symbols, and schematics. The 100 costs \$4500 to \$5500; the 300 is priced at \$7500 to \$11000; the 500 sells for \$6500 to \$7500; and the 700 costs \$9500 to \$13,000.

Viewlogic Systems Inc., 33 Boston Post Rd W, Marlboro, MA 01752. Phone (617) 480-0881.

Circle No 681



PC CAD SOFTWARE

Two software packages, the CDX-3100 and the CDX-3150, provide respective schematic-capture and CAE capabilities for IBM PC/XTs, PC/ATs, and compatible computers. The CDX-3100 borrows from the company's workstation-based systems' hierarchical schematic-capture and net-list extraction capabilities and icon-driven, object-oriented user interfaces. The CDX-3150 provides a PC-based interface to simulation servers accessed via an Ethernet LAN through a virtual-logic-analyzer user interface.

Instead of using a coprocessor board to increase system performance for pc-board design, these software packages rely on more powerful servers accessible over the

ADEE EAST

network. This approach also relies on network file servers for storing design libraries, which may require tens of megabytes of disk storage. All PC stations on the network can share libraries on the file servers. You can develop large designs on a personal computer, which would normally exceed its RAM or disk-storage capacities, by using the network resources' greater performance ability and storage capacity. The CDX-3100 costs \$7900; the CDX-3150 costs \$2500.

Cadnetix Corp., 5757 Central Ave., Boulder, CO 80301. Phone (303) 444-8075.

Circle No 680

ANALOG DESIGN

The Smoke Alarm and the Power Design modules are two additions to the company's Analog Workbench and PC Workbench analog CAE design tools. Smoke Alarm analyzes safe operating areas for passive and semiconductor components as well as power supplies in an analog design, and it flags components operating outside of current, voltage, or power specifications. The Smoke Alarm examines peak and average ratings during operation, and you can derate specifications for wider design margins. The Smoke Alarm module costs \$10,000 for the Analog Workbench and \$6000 for the PC Workbench.

The Power Design module contains nonlinear hysteresis models for transformer characteristics, thus overcoming the difficulties that the Analog and PC Workbench tools, which are based on the Spice simulator, have with nonlinear magnetic models. It also contains a model library that includes PWM and current-mode controller ICs. Power Design modules for the Analog and PC Workbench cost \$7500 and \$5000, respectively.

Analog Design Tools Inc., 66 Willow Place, Menlo Park, CA 94025. Phone (415) 328-0780.

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CIRCLE NO 17



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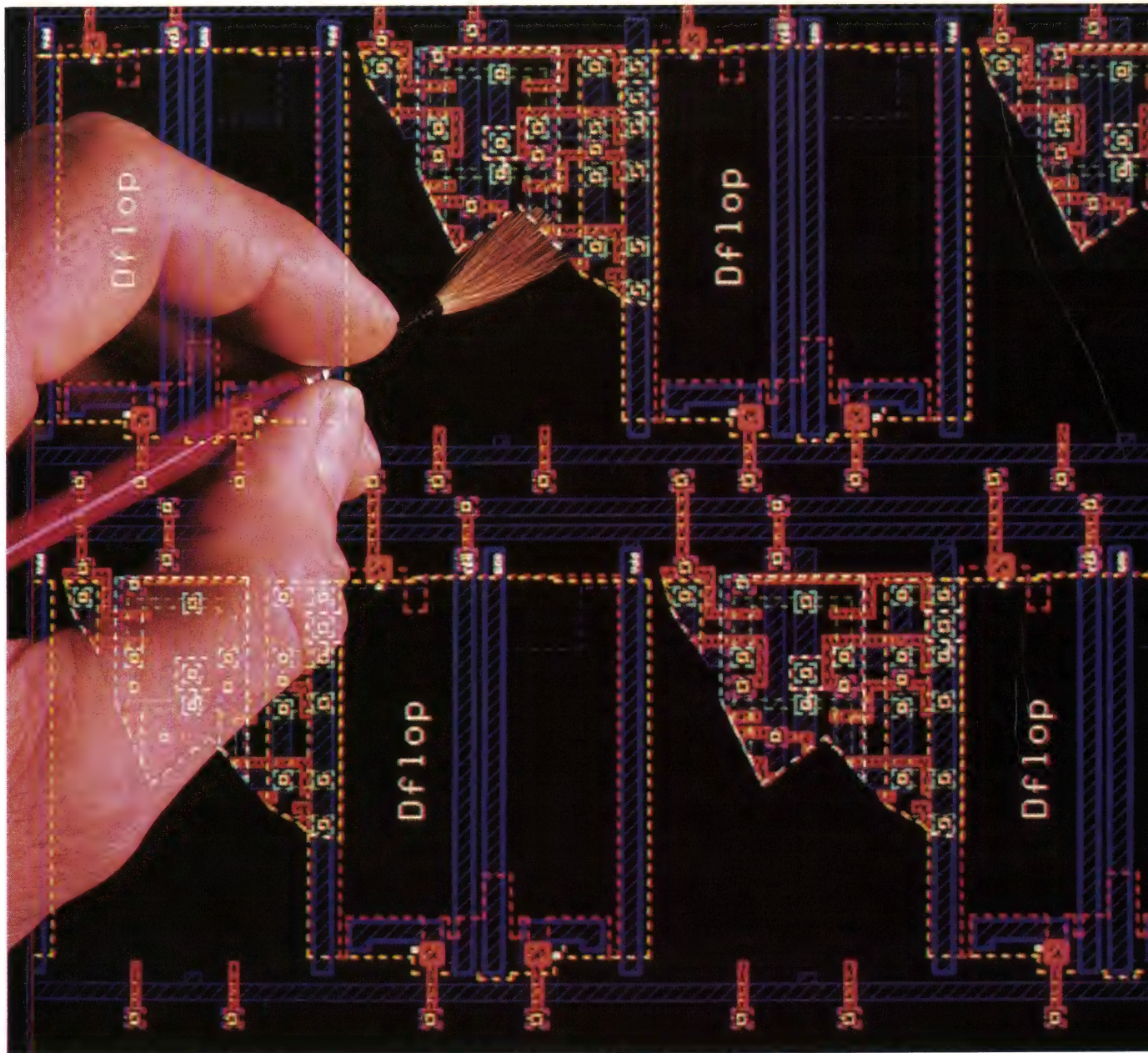
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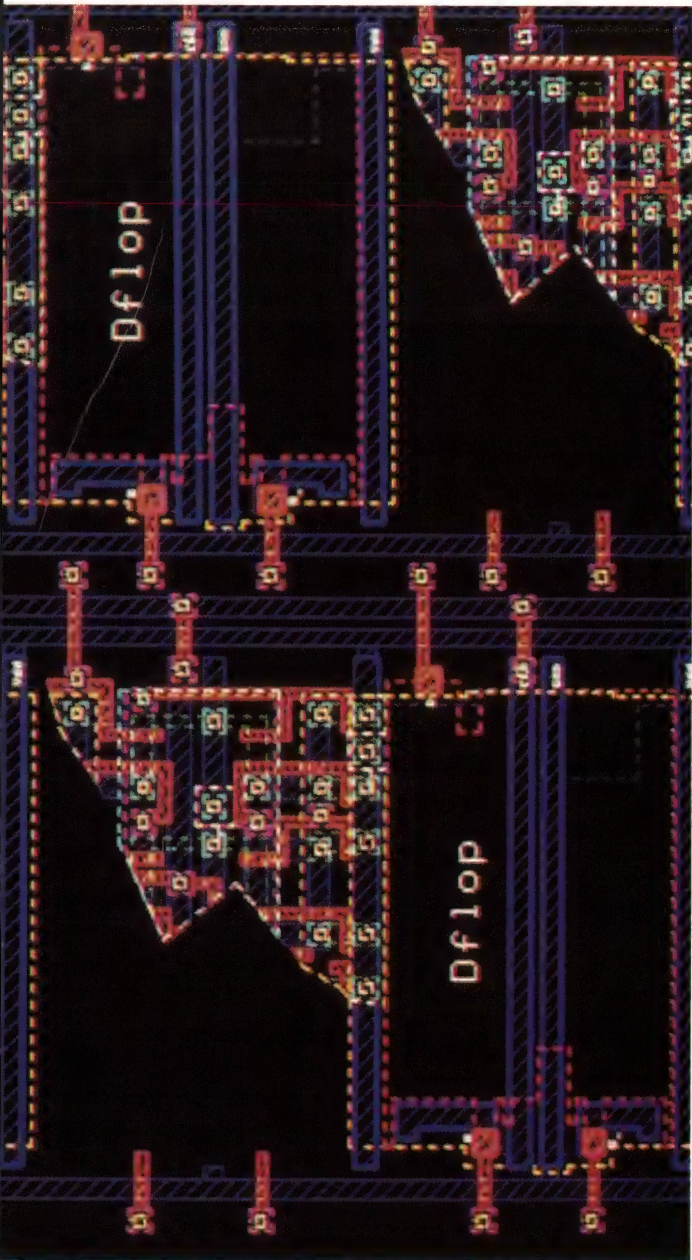
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and grew with the addition of emulators for the 8051, 8052 and 8044 devices. A commitment that will continue to grow as the MCS-51 microcomputer family expands.

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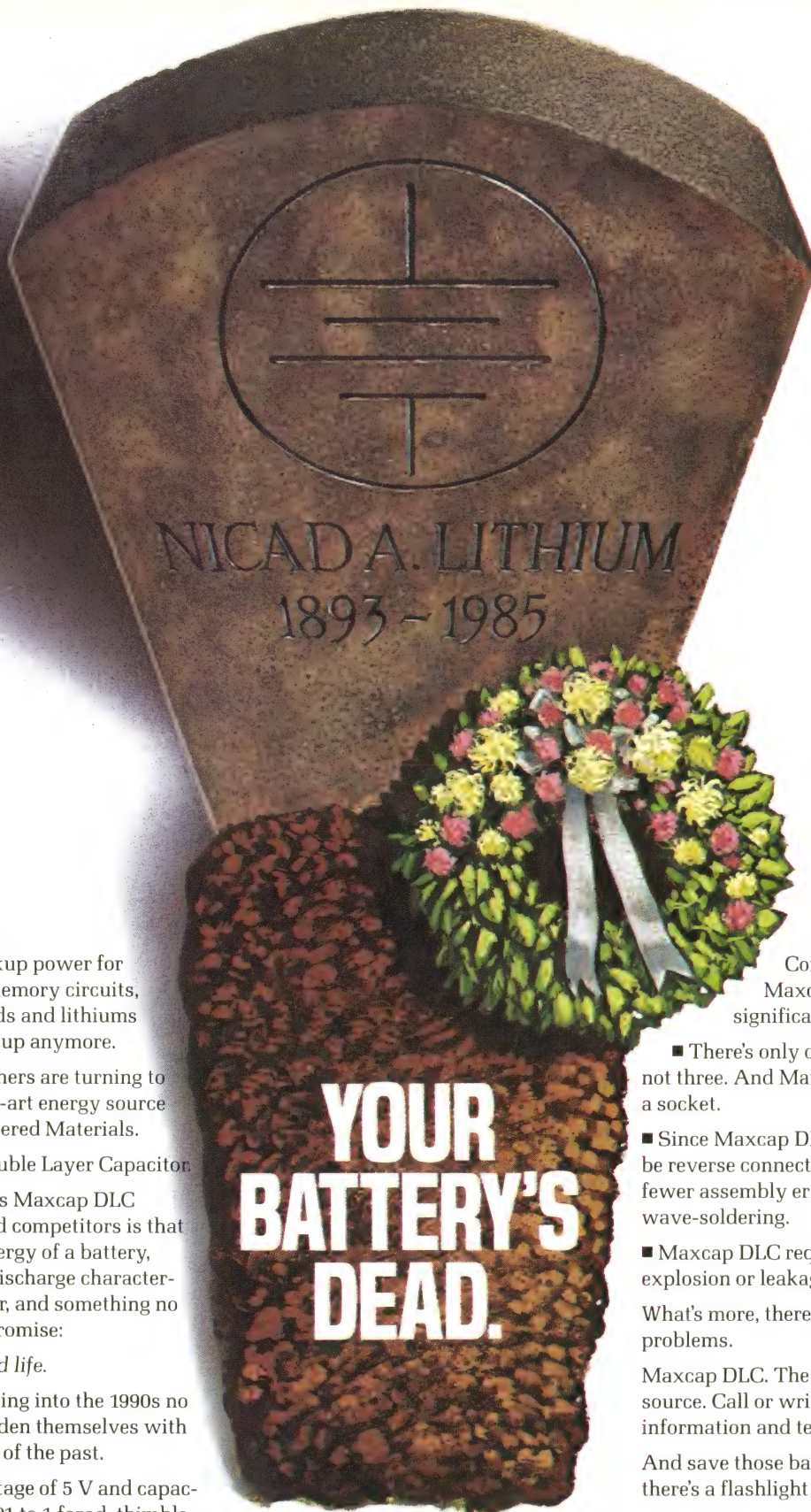
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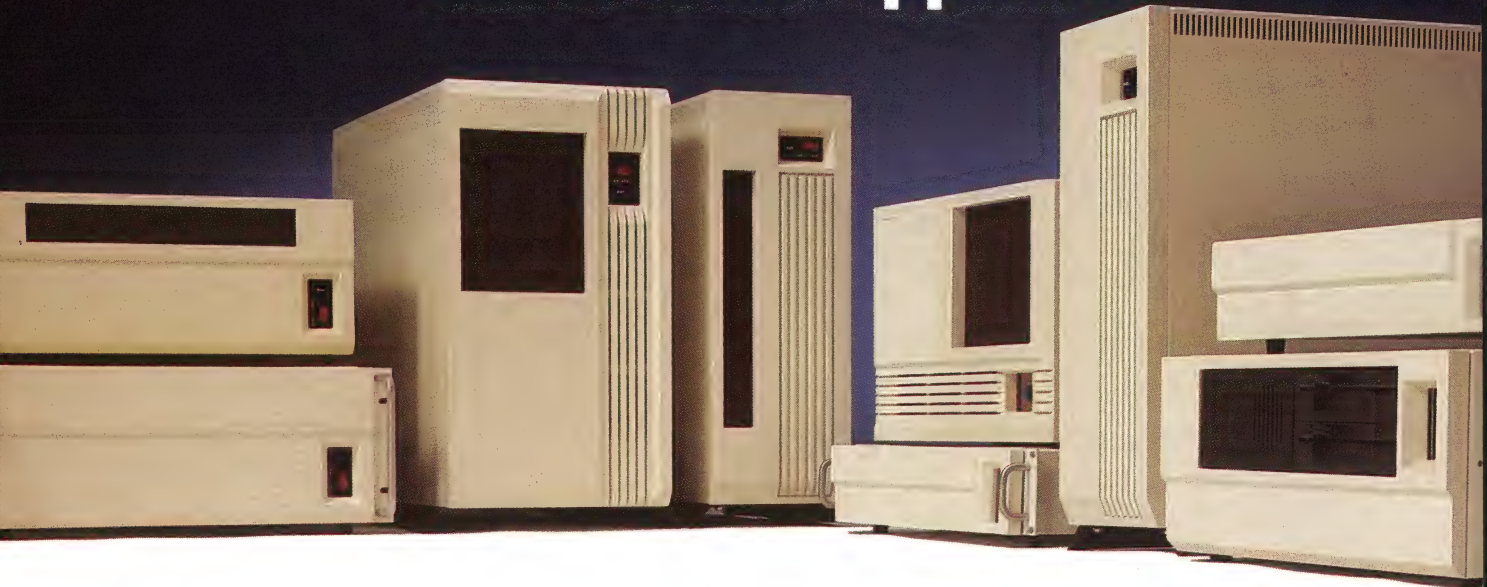
Maxcap DLC shown actual size above.



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CIRCLE NO 207

VME, Multibus and Multibus II: Package Your System to Win World-Wide Approval



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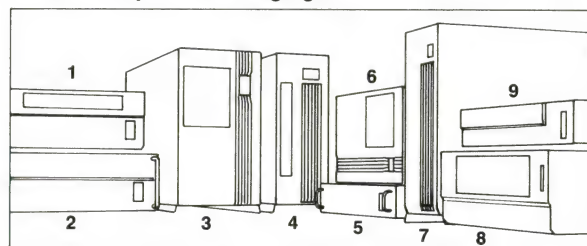
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3. Series 10 DeskMate with 4 full-/8 half-height peripherals
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5. Series 3 (shown with rack mounting)
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6. Series 10 with 4 full-/8 half-height peripherals
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7 slots VME, Multibus II; 10 slots Multibus I
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PRODUCT UPDATE

Single-device, 2400-bps modem simplifies fax-machine design

You can implement the complex modem design for a Group 3 facsimile (fax) machine with the R24MFX Monofax, a 2400-bps modem that comes in a 64-pin quad-in-line package. This modem, the first of its kind, supports the CCITT Recommendation V.27 ter fallback mode (2400 bps) and the V.21 channel 2 mode (300 bps). The device can generate line-quality diagnostic data, and it supports adaptive equalization, a procedure that automatically compensates for line-quality distortion.

The modem comes with two data-transmission-equipment (DTE) interfaces: a CCITT V.24 (RS-232C) port and a microprocessor bus interface. This bus interface allows the host microprocessor to change the modem configuration, read or write

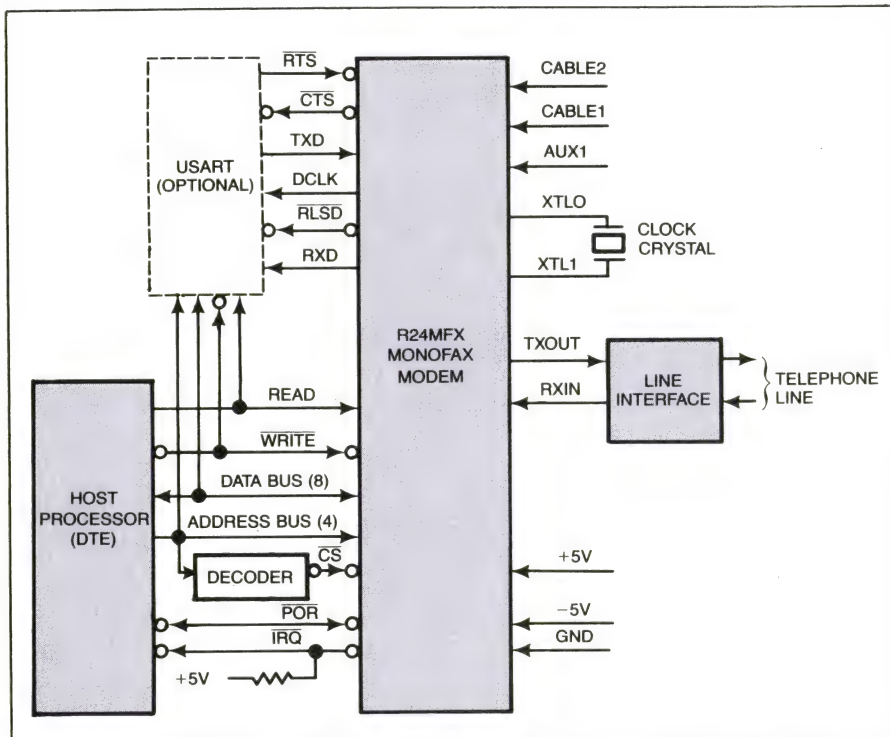
channel data or diagnostic data, and supervise modem operation by means of control bits and modem-status bits that you can set via software.

The transmit output level is programmable—a feature that's useful because of the variation in non-US transmit-output-level standards. Other programmable features include tone detection, dual-tone generation, and a receiver-threshold range of 0 to -43 dBm. The R24MFX Monofax consumes 1W typ and costs \$40 (1000).

—Margery S Conner

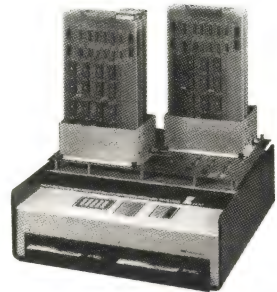
Rockwell International, Semiconductor Products Div, 4311 Jambooree Rd, Newport Beach, CA 92658. Phone (714) 833-4700.

Circle No 727



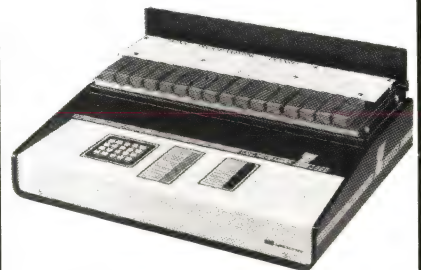
Offering a variety of programmable options, the R24MFX Monofax is a single-device 2400-bps facsimile modem. The optional USART shown offloads the serial communications overhead from the host processor.

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Z-2500B IN-CIRCUIT MEMORY CARD PROGRAMMER

- Programs and tests up to 32 customer memory cards populated with EPROMs or microcomputers at a time.
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CIRCLE NO 20

PRODUCT UPDATE

PC-based digital scope features 500-kHz sample rate

The 4-channel R4X4 digital oscilloscope combines the high sampling rates and triggering capabilities of a stand-alone scope with the flexibility and low price of a PC-based peripheral. Each of the scope's channels has a dedicated 8-bit A/D converter; phase accuracy between channels is $\pm 3^\circ$. The scope has deep data buffers (32,767 bytes per buffer) that can be filled at sampling rates ranging from 0.1 Hz to 500 kHz per channel. You can partition the buffer from the keyboard to allow both pre- and post-triggering. During data acquisition, you can actively scroll forwards and backwards on the display with the cursor. The zoom mode lets you expand the display by a factor of 1 to 2000.

You use a menu to select the digital trigger for any channel; as with a stand-alone unit, you select manual trigger adjust and polarity via a potentiometer and a switch, respectively. The scope's ac bandwidth is

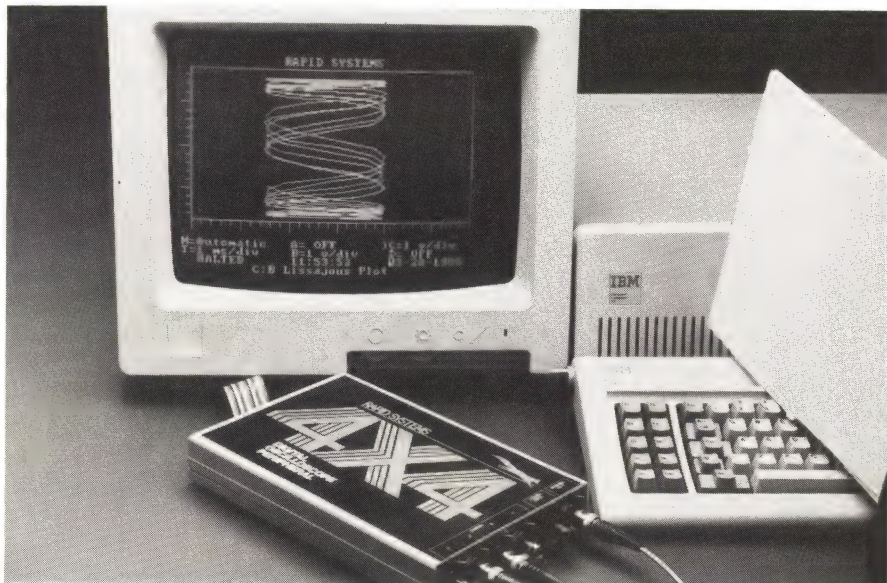
10 Hz to 250 kHz in all gain ranges.

When the unit is in autoseek mode, you don't have to specify the sampling frequency for a waveform—the scope determines the input signal's frequency and samples at a rate 10 times higher. Once you've stored the acquired waveform to the PC's disk, you can retrieve the acquired signal and compare it to real-time data. The data-file format is compatible with such data-reduction software as Lotus 1-2-3 and DADISP.

The R4X4 is attached via a 24-in. ribbon cable to a half-size interface card that plugs into an IBM PC, PC/XT, or PC/AT, or a compatible computer. The unit runs from the PC's power supply; it requires 5V at 350 mA max and $\pm 12\text{V}$ at 70 mA max. \$1995.—**Margery S Conner**

Rapid Systems, Inc., 755 N Northlake Way, Seattle, WA 98103.
Phone (206) 547-8311.

Circle No 726



Each of the four channels on the PC-based R4X4 digital oscilloscope has a dedicated 8-bit A/D converter and a 32,767-byte buffer. The scope samples at as much as 500k bytes/sec per channel.

We're committed to keeping robots in power.

When you're designing for industrial electronics applications, there's one fact you should keep in mind: FACT. Fairchild Advanced CMOS Technology. The ideal CMOS logic family for today's state-of-the-art industrial applications. Including system controllers governing robots, conveyor belts, or other computers.

FACT can optimize system performance like no other logic family. Its noise immunity, for instance, is the best in the industry – typically 1.25V. Making it the logical choice for industrial applications where noise is extreme.

The FACT family's latch-up immunity is also superior to any standard metal gate CMOS line. FACT parts won't latch up at 100mA in worst-case conditions ($T_A = 125^\circ\text{C}$ and $V_{CC} = 5.5\text{V}$). Typically, they'll handle currents as high as 300mA on their outputs. So your robots will, too.

Other reasons to use FACT logic circuits are just as compelling:

Such as a -40°C to $+85^\circ\text{C}$ industrial temperature range. Guaranteed AC and DC specs with power supply voltages of 3V and $5\text{V} \pm 10\%$. A guaranteed

ESD immunity of 2,000V, typically 4,000V. Consistent, across-the-line specifications. And low operating power consumption of $5\mu\text{W/gate}$.

Speed? FACT ICs are manufactured with a 1.2-micron process, resulting in CMOS logic parts with speed second to none. And to make sure the FACTs are there when you need them, they're available now from any authorized Fairchild distributor or sales office. For more information, call The Fairchild Information Center at 1-800-554-4443.

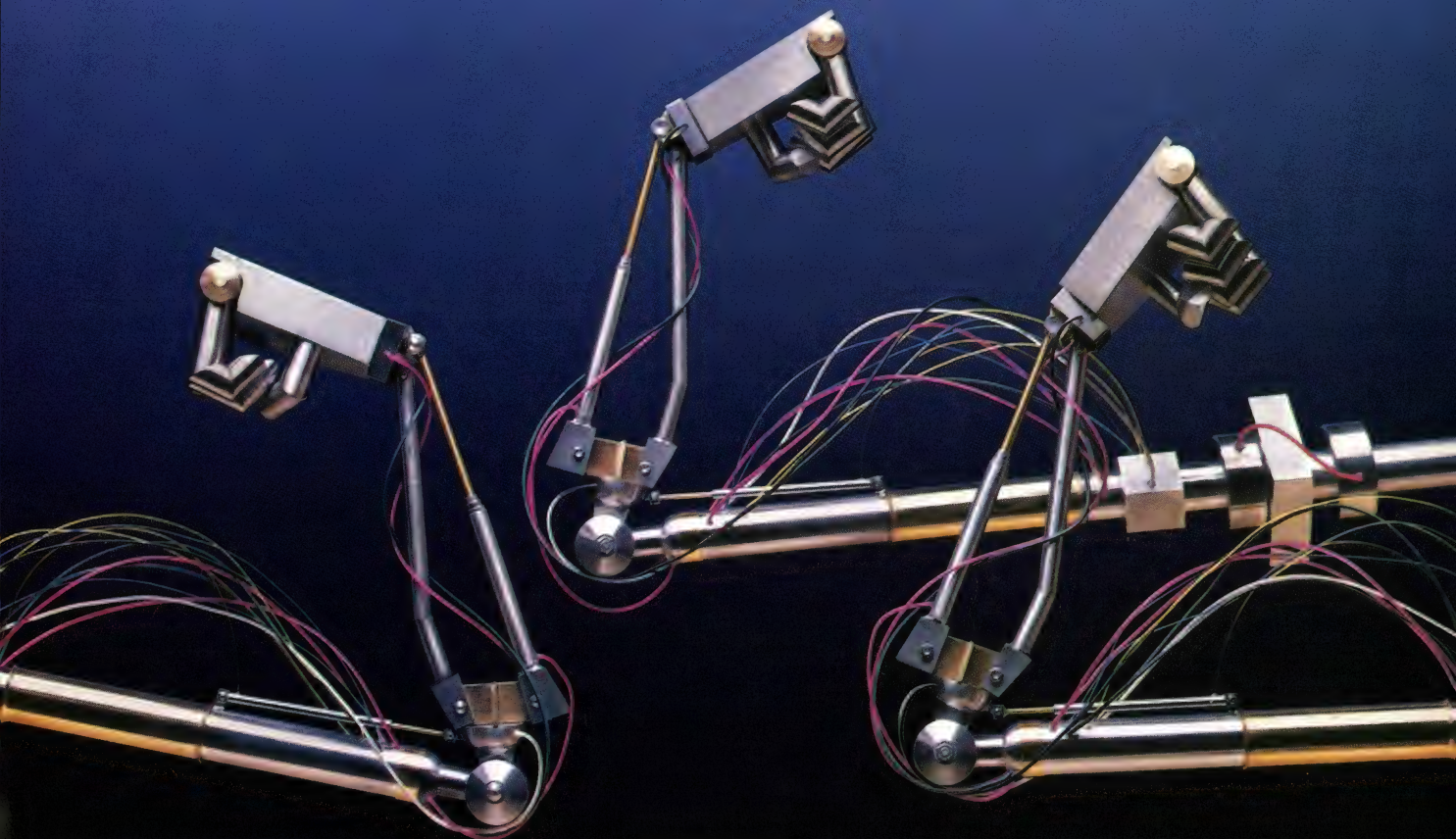
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Our fast static RAM family includes the first 5-volt 4Kx4s designed to operate at 20ns. The MK41L68 Series is also the industry's first LSI circuit specifically designed for the new scaled MOS 3.3-volt LV-TTL JEDEC standard. And they're available with access times of 25ns or 35ns. Either way, they're the fastest 4Kx4 CMOS RAMs available anywhere.

A state-of-the-art sub micron double level metal CMOS process and a unique 6-transistor memory cell allows our new SRAMs to operate at high speeds yet maintain low operating and standby power requirements.

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CIRCLE NO 55

PRODUCT UPDATE

High-precision reference IC specs 1-ppm/C output drift

The AD588 monolithic voltage-reference IC specs ± 1 -mV max output-voltage error and ± 1 -ppm/C max output-voltage drift in its premium-grade version. The IC uses an ion-implanted, buried zener diode as its reference element and contains laser-trimmed (at the wafer stage) thin-film resistors.

The IC includes the reference cell and three additional amplifiers, which provide pin-programmable single-output ranges of +10, +5, -5, or -10V. The pin strapping also allows you to select dual outputs of ± 5 V (tracking), +5 and +10V, or -5 and -10V. The amplifiers allow you to make Kelvin connections to the load, to boosters that you might employ for driving long lines or high-current loads, or to both.

The AD588's ± 1 -mV accuracy makes it suitable as a reference for 12-bit D/A or A/D converters (1 mV represents less than 1 LSB in a 12-bit, 10V system). You can optionally use the device's fine-trim connections to obtain even greater accuracy; the fine trimming does not alter the operating conditions of the

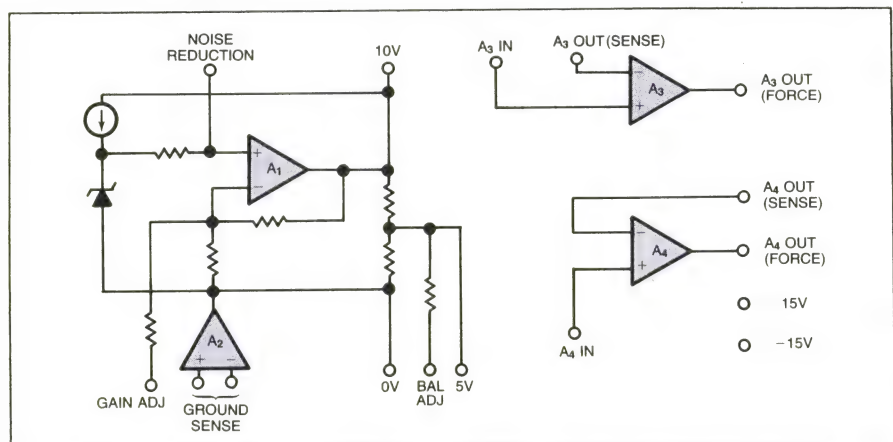
zener reference or the buffer amplifiers. The fine trim, therefore, does not increase the AD588's temperature drift.

Guaranteed long-term stability for the premium-grade versions is 25 ppm over 1000 hours. The typical output noise is 10 μ V p-p; a noise-reduction pin allows you to reduce this voltage further by filtering with an external capacitor. Tracking error in the ± 5 V output mode is less than 1 mV; a fine-trim terminal allows you to reduce the tracking error even further.

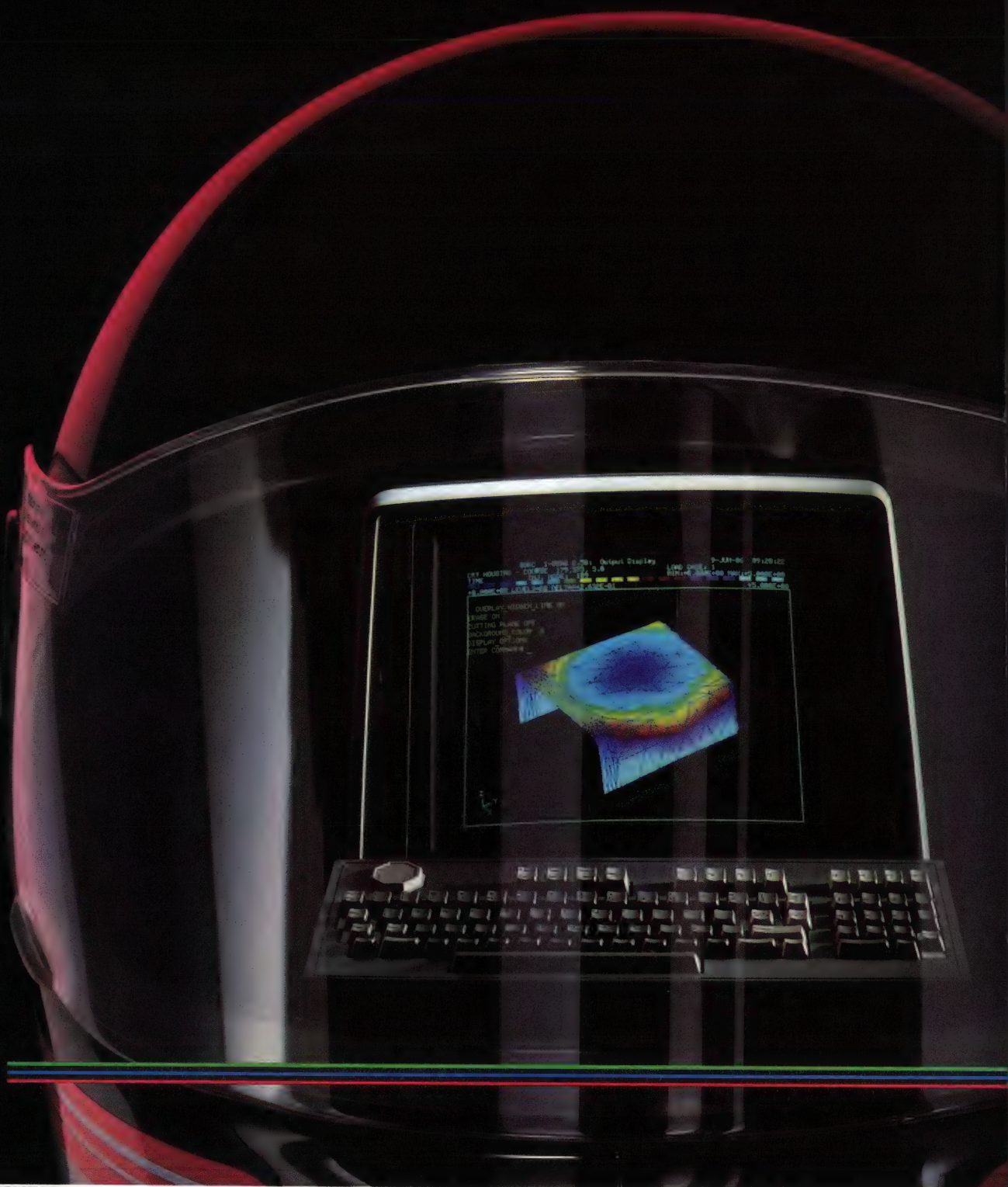
Other specs for the AD588 include ± 100 - μ V/V line regulation and ± 100 - μ V/mA load regulation. Available in versions that operate over 0 to 70°C, -25 to +85°C, or -55 to +125°C, the AD588 comes in a 16-pin plastic or ceramic DIP. Versions in plastic and ceramic packages cost \$8.50 and \$12.75, respectively.—**Bill Travis**

Analog Devices Inc, Rte 1 Industrial Park, Norwood, MA 02062.
Phone (617) 329-4700.

Circle No 728



Providing as much stability and accuracy as expensive hybrid-circuit references do, the AD588 reference IC is a monolithic unit that's suitable as the reference element for 12-bit D/A and A/D converters. Three amplifiers allow you to eliminate ground drops and losses in load connections. Fine-trim terminals allow you to increase the unit's accuracy beyond the already tight 1 mV.



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It had to happen—the conventional microprocessor has had its day. Relegated to the ranks of yesterday's devices by the new transputer family from INMOS. It's history in the making.

The IMS T414 transputer is a fast, easy-to-use VLSI component, integrating a 32-bit processor, four inter-transputer communication links, 2K bytes Static RAM, 32-bit memory interface and DRAM controller. All on a single CMOS chip—offering execution rates up to 10 MIPs.

While transputers excel in single-processor systems, their real power can be unleashed by connecting any number of transputers together via the high-speed serial links. Multi-transputer systems can deliver the performance you need today, and can be easily expanded in the future as your processing requirements increase.

And there's more. Programming multiprocessor systems has never been easier. The Transputer Development System (TDS) supports C, Fortran, Pascal and OCCAM, providing a complete software development environment, and is available for a number of popular hosts. Software developed on the TDS can be executed on one or more transputers, enabling cost-performance tradeoffs to be made.

INMOS transputers are available now and have already found their way into companies who are evaluating, prototyping and manufacturing transputer-based systems. Applications include supercomputers, DSP, graphics, robotics, AI, distributed control systems, PC's, engineering workstations and many others.

Write or phone for more information on the transputer family and start making history yourself.

TRANSPUTER PRODUCTS	
IMS T414	32 bit Transputer—2Kbyte —4 links
IMS T212	16 bit Transputer—2Kbyte —4 links
IMS M212	16 bit DiscProcessor—1Kbyte—2 links
DEVELOPMENT TOOLS	
IMS D701-2	IBM PC—Transputer Development System.
IMS D600	VAX/VMS—Transputer Development System.
EVALUATION BOARDS	
IMS B002-2	Double Eurocard + IMS T414 + 2Mbyte DRAM + 2 x RS232.
IMS B003-1	Double Eurocard + 4 x IMS T414 + 4 x 256Kbyte DRAM.
IMS B004-2	IBM PC Format + IMS T414 + 2Mbyte DRAM.
IMS B006-2	Double Eurocard + 9 x IMS T212 + 128Kbyte SRAM.
IMS B007-1	Double Eurocard + IMS T414 + 0.5Mbyte DRAM + 0.5Mbyte Video RAM.
HIGH PERFORMANCE VLSI MEMORIES	
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CIRCLE NO 150

READERS' CHOICE

Of all the new products covered in EDN's **June 26, 1986**, issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, find out what makes them special: Just circle the appropriate numbers on the Information Retrieval Service card, or refer to the indicated pages in our **June 26, 1986**, issue.

► DEVELOPMENT SYSTEM

The ICE (in-circuit emulator) is a personal-computer-based system that lets you define and test a number of audio-based filter parameters (pg 112).

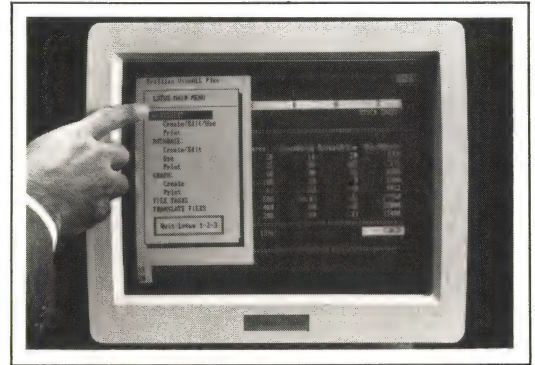
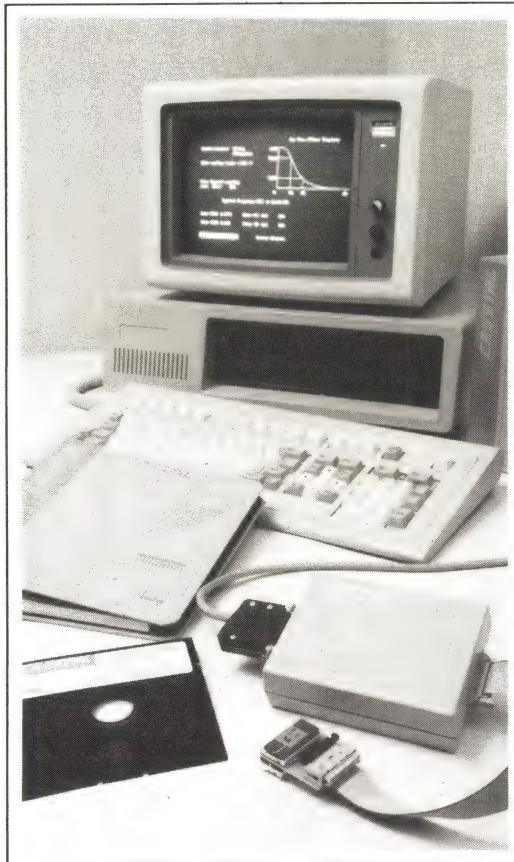
Crystal Semiconductor Corp.

Circle No 605

▼ TERMINAL ADAPTER

The LDA-232 adapter allows any RS-232C computer terminal to transmit asynchronous data more than three miles at speeds to 19,000 bps (pg 252).

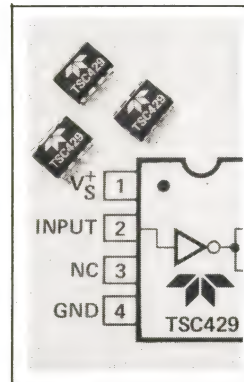
Equinox Systems Inc. Circle No 603



▲ TOUCH SCREEN

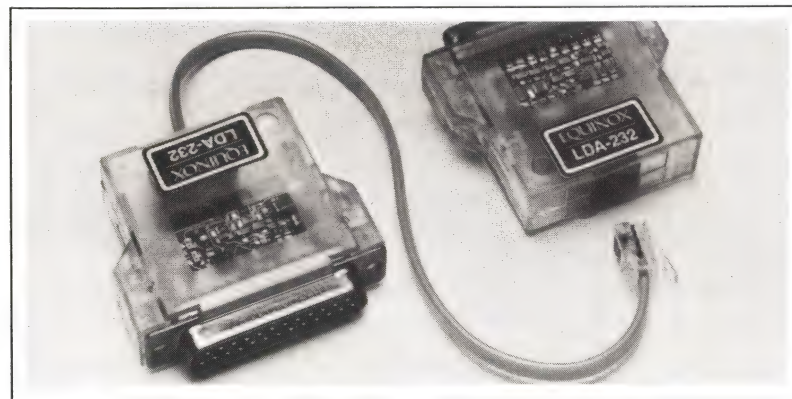
The TouchMonitor 14 is a 14-in., IBM compatible monochrome monitor. It tilts, swivels, and runs with either 110 or 230V power supply (pg 245).

Personal Touch Corp. Circle No 602



◀ DRIVER IC

The CMOS-processed TSC429 is designed to drive power MOSFETs and simplify the drive circuitry for very large MOSFETs (pg 108).
Teledyne Semiconductor. Circle No 604

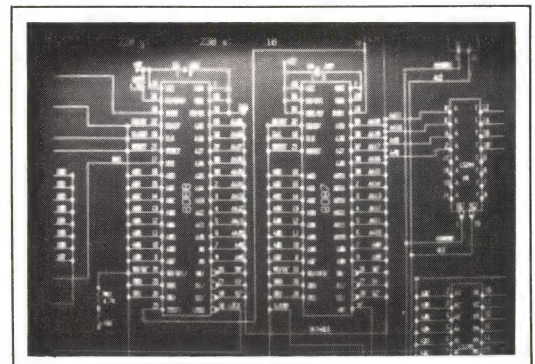
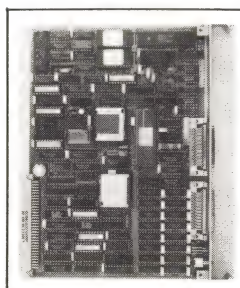


► CPU BOARDS

The VMEx 286 and VMEx J11 bring the 80286 and J11 μ Ps to the VME Bus (pg 114).

Iskra VME Technologies.

Circle No 606



▲ PC-BASED CAE/CAD

The Draftsman-EE, DC/Autorouter, and DC/Netlist, capture drawings, automatically route pc boards, and generate net lists, respectively (pg 238).

Design Computation Inc. Circle No 601



**HP has something to
say to oscilloscope users...**

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No. 1 in a series.

Explore HP Digitizing Oscilloscopes.

Digitizing architecture is making scopes easier to use, and more efficient.

The move toward digitizing architecture in oscilloscopes is on. New digitizing scopes are easier to use, and can dramatically boost measurement efficiency for engineers and technicians in many applications.

Simple instrument setup.

With the new HP 54000 series digitizing oscilloscopes, you get a stable display on the screen faster, even if other users have left the scope in an unfamiliar operating mode. You simply push the "autoscale" button on the front panel. Your signal is correctly displayed on the screen. It all happens automatically, in seconds.

You can also store front-panel setups in memory for later use...a convenient feature, especially if your application calls for repeating several different instrument setups, or if the scope is shared by many users.

Automatic answers.

With conventional scopes, making measurements such as risetime or frequency is typically a lengthy process, involving manual calculations. With the HP 54000 series, you can make these measurements, and many more, automatically. That's because they are computed for you at the touch of a button from digitized information.

Instant hardcopy output.

If you've ever fussed with oscilloscope cameras trying to photograph traces, you'll appreciate the digitizing difference. You simply push a button on the front panel of the HP 54000 series to get hardcopy of the waveform of interest, or scope setup, on HP graphic printers, or plotters.

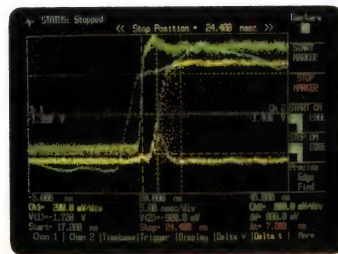


No more grease pencils.

Unlike their conventional analog counterparts, digitizing oscilloscopes can store waveforms in memory. So you can call them up for later reference, or compare them on the display with "live" waveforms, without parallax. Traces remain clear and sharp, so you can make accurate measurements without time limits, even on stored and recalled traces.

Multiple colors enhance scope functionality.

Multiple, selectable display colors let you distinguish overlapping traces more easily. Associate waveforms with corresponding measurement and setup data. Emphasize special conditions, such as the color red indicating when measured data is outside of control limits. And tailor the system to your own way of working—to improve contrast or aid recognition, for example. Functional color is available on the HP 54110D digitizing oscilloscope.



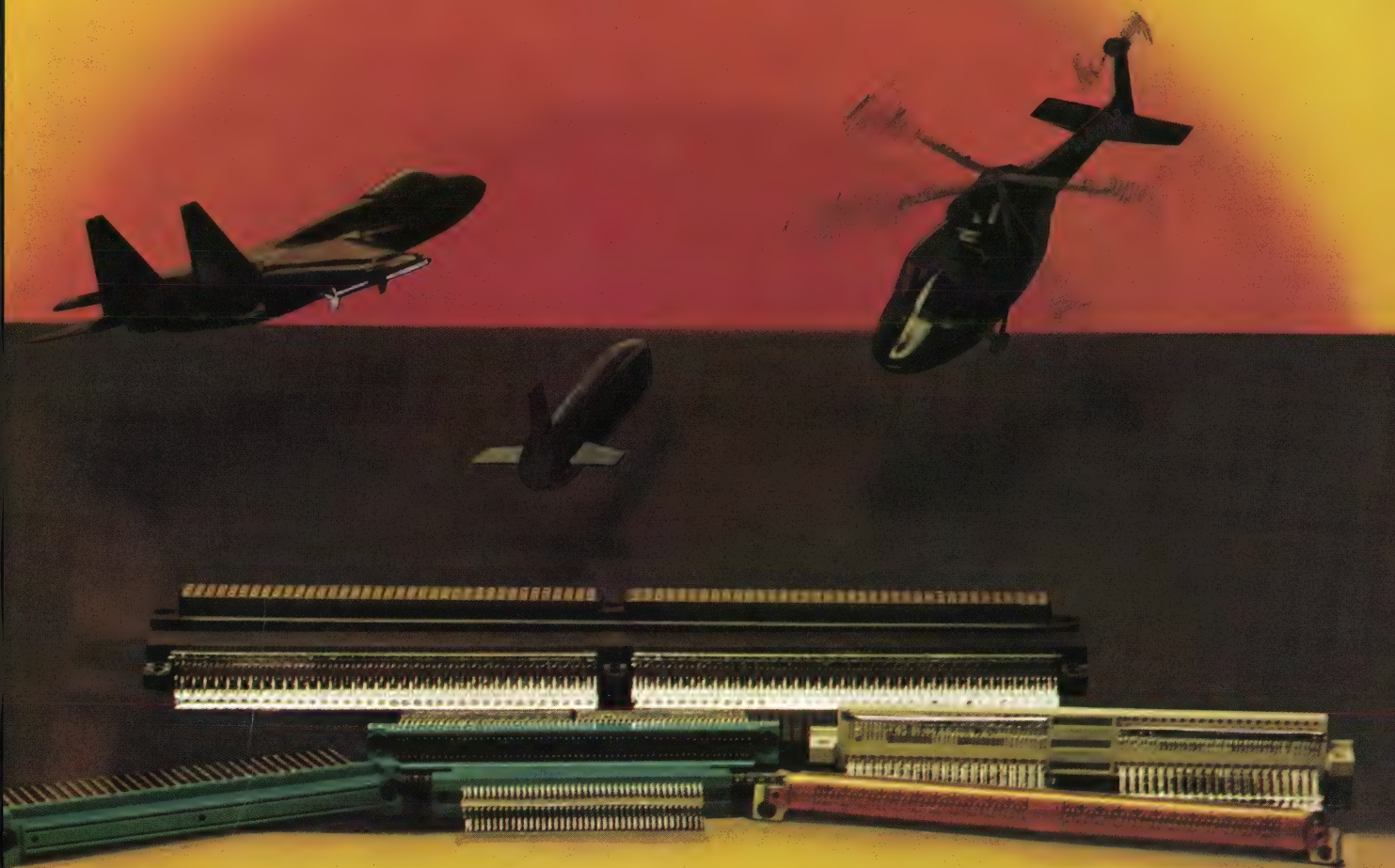
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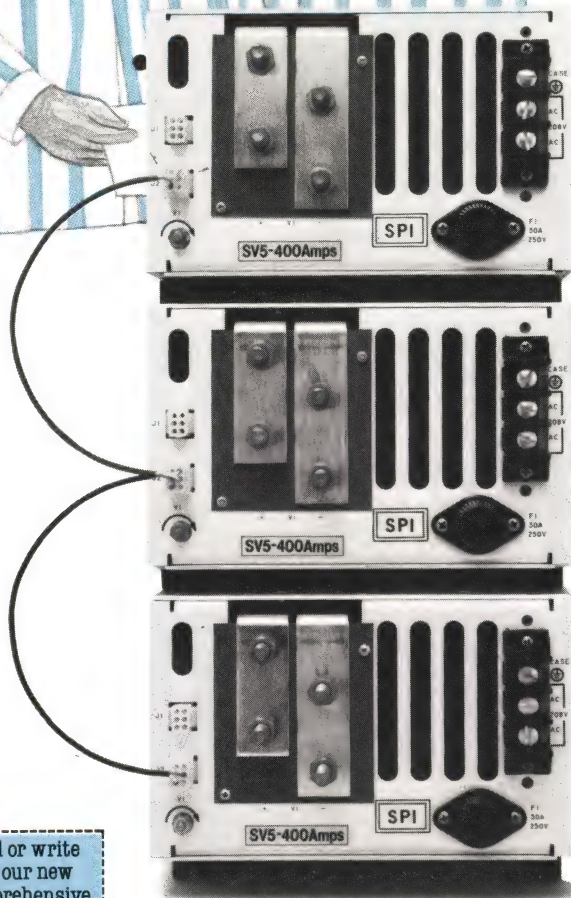
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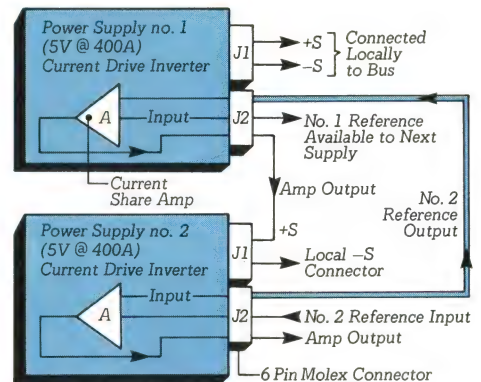
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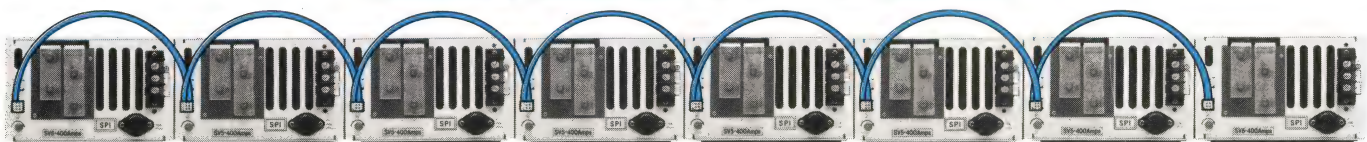
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CIRCLE NO 152

LEADTIME INDEX

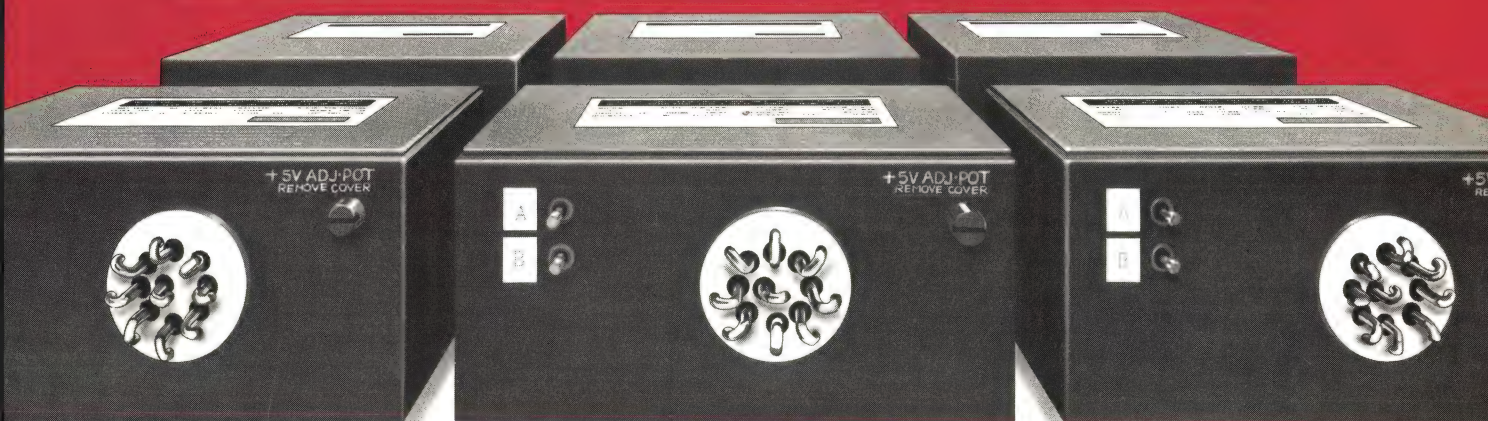
Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Last month's average (weeks)	Average (weeks)
TRANSFORMERS								
Toroidal	0	19	50	25	6	0	10.0	10.7
Pot-Core	6	25	38	25	0	6	9.4	8.5
Laminate (power)	4	26	49	17	4	0	8.3	6.0
CONNECTORS								
Military panel	0	25	50	8	8	9	10.6	15.4
Flat/Cable	11	47	26	16	0	0	5.6	4.3
Multipin circular	8	15	46	15	8	8	10.8	8.7
PC	7	43	22	21	7	0	7.9	4.6
RF/Coaxial	23	23	23	31	0	0	7.2	7.5
Socket	13	31	31	19	6	0	7.8	4.9
Terminal blocks	24	33	33	10	0	0	4.9	4.9
Edge card	4	52	26	13	5	0	6.3	5.2
Subminiature	6	29	47	6	12	0	8.4	12.0
Rack & panel	0	42	25	33	0	0	8.2	8.0
Power	12	41	24	18	5	0	7.1	6.3
PRINTED CIRCUIT BOARDS								
Single-sided	0	56	40	4	0	0	5.0	5.6
Double-sided	0	43	53	4	0	0	5.7	5.3
Multilayer	0	24	48	29	0	0	8.9	6.0
Prototype	5	67	28	0	0	0	3.6	5.4
RESISTORS								
Carbon film	44	26	19	11	0	0	3.8	3.1
Carbon composition	18	27	27	28	0	0	7.1	4.1
Metal film	30	15	40	15	0	0	5.9	4.7
Metal oxide	23	23	31	23	0	0	6.6	6.3
Wirewound	12	38	33	17	0	0	6.1	6.0
Potentiometers	10	31	31	24	4	0	7.9	7.9
Networks	9	33	29	29	0	0	7.5	4.6
FUSES								
	32	36	27	5	0	0	3.6	2.5
SWITCHES								
Pushbutton	19	48	14	19	0	0	5.1	3.8
Rotary	15	35	25	20	5	0	7.2	5.0
Rocker	6	50	17	22	5	0	7.3	5.6
Thumbwheel	0	25	25	42	8	0	11.3	6.5
Snap action	15	31	23	31	0	0	7.4	4.0
Momentary	21	29	21	29	0	0	6.9	6.5
Dual in-line	21	21	29	22	7	0	8.0	5.0
WIRE AND CABLE								
Coaxial	17	53	24	6	0	0	3.9	2.0
Flat ribbon	27	41	23	5	4	0	4.5	3.4
Multiconductor	30	30	30	5	5	0	5.1	4.6
Hookup	54	25	18	3	0	0	2.5	2.0
Wire wrap	50	19	19	12	0	0	3.9	3.1
Power cords	30	35	26	9	0	0	4.2	4.1
Other	17	17	33	33	0	0	8.3	8.0
POWER SUPPLIES								
Switching	6	33	28	22	11	0	9.3	8.0
Linear	13	19	44	12	12	0	9.1	4.6
CIRCUIT BREAKERS								
	25	13	12	50	0	0	9.3	5.4
HEAT SINKS								
	20	20	40	15	5	0	7.3	3.8

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Last month's average (weeks)	Average (weeks)
RELAYS								
General purpose	24	32	20	20	4	0	6.5	4.3
PC board	10	40	20	25	5	0	7.7	8.7
Dry reed	13	12	38	25	12	0	10.5	8.0
Mercury	0	17	33	33	0	17	13.5	8.0
Solid state	13	40	13	20	7	7	8.9	4.0
DISCRETE SEMICONDUCTORS								
Diode	16	48	20	13	3	0	5.4	6.7
Zener	15	46	23	16	0	0	5.2	6.9
Thyristor	14	29	38	14	5	0	7.1	12.8
Small signal transistor	23	27	23	23	0	4	7.3	8.0
FET, MOS	9	41	23	23	0	4	7.7	10.0
Power, bipolar	17	28	28	22	0	5	8.1	14.5
INTEGRATED CIRCUITS, DIGITAL								
CMOS	11	31	35	19	4	0	7.5	8.8
TTL	21	17	33	25	4	0	8.1	8.3
LS	16	20	32	28	4	0	8.5	7.3
INTEGRATED CIRCUITS, LINEAR								
Communication/circuit	7	13	47	27	6	0	10.0	10.7
OP amplifier	9	30	30	22	9	0	8.8	8.8
Voltage regulator	15	35	31	15	4	0	6.6	9.1
MEMORY CIRCUITS								
RAM 16K	0	44	33	17	6	0	7.7	10.0
RAM 64K	0	53	32	10	0	5	6.9	10.0
RAM 256K	0	36	43	14	0	7	8.6	14.0
ROM/PROM	0	29	41	24	0	6	9.5	10.7
EPROM	4	36	32	24	0	4	8.4	9.5
EEPROM	0	29	28	36	0	7	10.8	10.7
DISPLAYS								
Panel meters	8	25	50	8	9	0	8.0	7.5
Fluorescent	11	22	22	34	11	0	10.4	5.2
Incandescent	0	17	33	33	17	0	12.7	4.7
LED	4	50	25	17	4	0	6.8	6.5
Liquid crystal	7	20	40	27	6	0	4.6	7.5
MICROPROCESSOR ICs								
8-bit	9	27	36	23	0	5	8.5	8.5
16-bit	6	18	53	23	0	0	8.5	10.4
FUNCTION PACKAGES								
Amplifier	10	20	30	30	0	10	10.7	12.0
Converter, analog to digital	0	13	56	25	0	6	10.7	8.5
Converter, digital to analog	0	19	44	31	0	6	10.3	8.7
LINE FILTERS								
	0	37	36	18	9	0	8.9	3.5
CAPACITORS								
Ceramic	17	33	33	17	0	0	6.0	5.3
Ceramic monolithic	8	32	36	24	0	0	7.4	7.5
Ceramic disc	16	28	32	20	4	0	7.4	6.2
Film	16	24	36	20	4	0	7.6	4.8
Electrolytic	10	35	35	17	3	0	7.1	6.3
Tantalum	12	32	28	24	4	0	7.8	6.8
INDUCTORS								
	11	22	33	28	0	6	9.3	8.7

Source: Electronics Purchasing magazine's survey of buyers

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INPUT	320-480 Hz 115V ac ± 10% 100 watts	47-65 Hz 115V ac ± 10% 100 watts	dc 22-32V dc — 100 watts
OUTPUT	single 5, 12, 15, 24, 28V triple 5 ± 12V or 5 ± 15V	5, 12, 15, 24, 28V 5 ± 12V or 5 ± 15V	5, 12, 15, 24, 28V 5 ± 12V 5 ± 15V
SWITCHING	200 kHz	200 kHz	200 kHz
FREQUENCY	65%-80%	65%-80%	65%-80%
EFFICIENCY	0.5%-2%	0.5%-2%	0.5%-2%
RIPPLE/NOISE	10 mV	10 mV	10 mV
LINE & LOAD	MIL-STD-461B	MIL-STD-461B	MIL-STD-461B
REGULATION	MIL-STD-810C	MIL-STD-810C	MIL-STD-810C
EMI	MIL-S-901C	MIL-S-901C	MIL-S-901C
ENVIRONMENT	MIL-STD-704D	MIL-STD-1399	MIL-STD-704D
INPUT			
PROTECTION			
TEMPERATURE			
operating	-55°C to +100°C	-20°C to +71°C	-55°C to +100°C
storage	-65°C to +125°C	-55°C to +85°C	-65°C to +125°C
MTBF*	99,408 hours	97,935 hours	140,000 hours
(minimum—ground benign)			

*MIL-STD-217D (50°C baseplate)

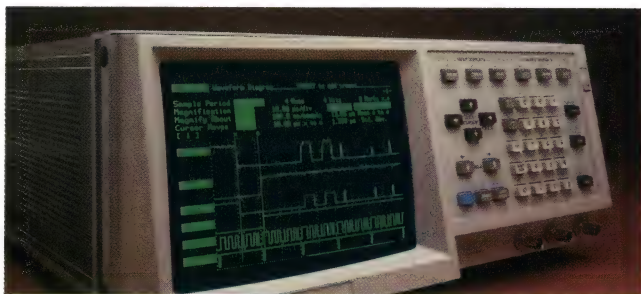
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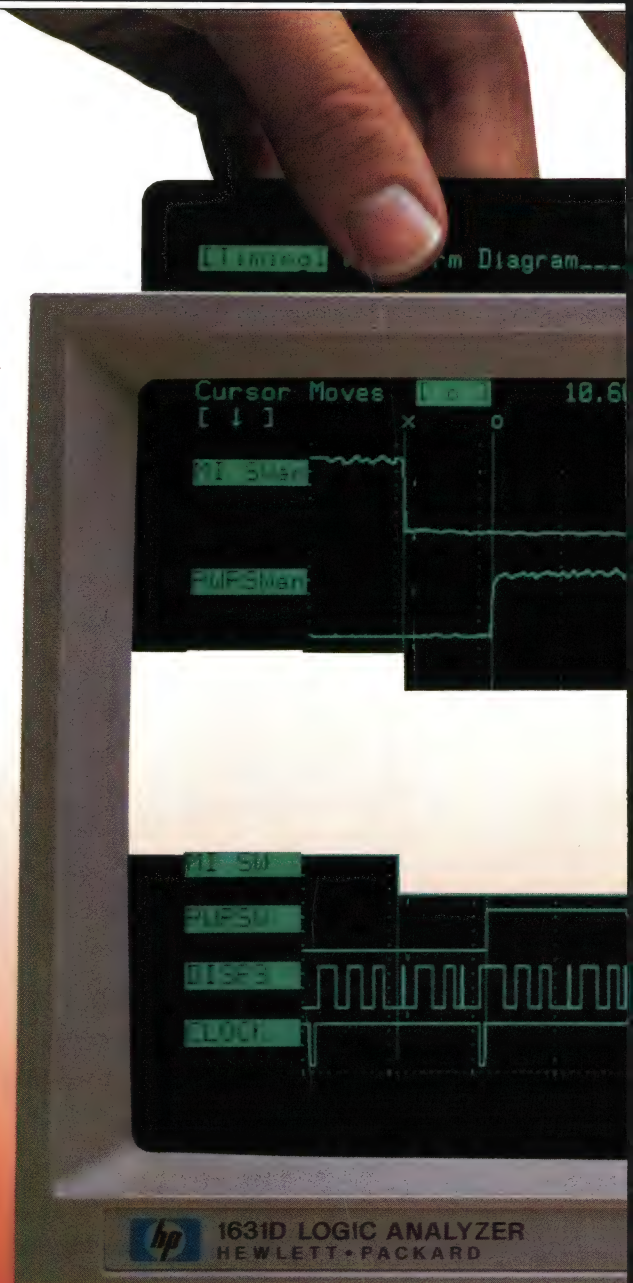


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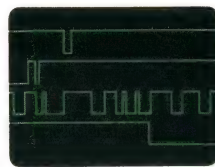
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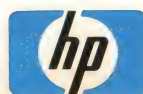
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Special
Report

High-performance oscilloscopes



This year, more high-performance oscilloscopes than ever are available in the 150-MHz to 1-GHz bandwidth range. Unlike earlier high-performance scopes, many recent models offer extra features—such as onscreen cursors, LCD readouts, and automatic setup—that make them easier to use and improve their productivity.

Chris Everett, *Regional Editor*

The 1-GHz real-time oscilloscope that was introduced several years ago (Tektronix's Model 7104) is still the fastest of its kind. Until recently, however, you could select from very few scopes in the range between this 1-GHz model and the 100-MHz workhorse. Today, you can choose from a much wider selection of high-performance scopes (see **Table 1** on pg 136 and **Table 2**, which begins on pg 148). These scopes, which generally exhibit bandwidths of 150 MHz or higher, include real-time models as well as digital and analog storage models.

Unlike previous high-performance scopes, which were often difficult to operate, these new high-performance scopes incorporate a number of features that make them easy to use. For instance, many offer automatic-setup features, which put your trace on the screen quickly so that you can start taking measurements right away. Further, these scopes also have additional measurement features—such as onscreen cursors, envelope storage mode, and setup storage—that allow you to take faster, more accurate measurements. Although many of these measurement features have been common on scopes with bandwidths lower than 150 MHz, they were heretofore unavailable on high-performance machines.

Although Tektronix introduced the Model 7104 more than five years ago, that 1-GHz scope is still the fastest nonstorage oscilloscope available. When you add the 7A29 vertical plug-in module to the 7104 mainframe,

You needn't sacrifice measurement features to achieve high performance with top-of-the-line oscilloscopes. These scopes now offer specs like 4-div/nsec writing speeds as well as such features as automatic setup and ΔT measurement capability. (Photo courtesy Philips Test & Measuring Instruments Inc)



500-MHz single-shot events are easily captured by Tektronix's 7934 analog storage oscilloscope. The 7934's 700-psec rise time and 4-cm/nsec writing speed makes it the fastest direct-storage oscilloscope available.

you can measure rise times as short as 350 psec with less than 2% error.

When coupled with either the 7B10 or 7B15 timebase modules, the 7104 can sweep a signal at 200 psec/div. The 7104's visual writing speed is fast enough for you to view a 1-GHz single-shot event under normal room conditions. The 7104's photographic writing speed is at least 20 cm/nsec, or approximately two-thirds the speed of light.

At the opposite end of the high-performance range are the 150-MHz Tektronix 2445A and Kikusui COS6150. The 2445A, which has a 150-MHz bandwidth, is a 4-channel scope. It provides cursors that let you make both delta voltage (ΔV) and delta time (ΔT) measurements with the 2445A's cursors. An option lets you resolve time-interval measurements to 10 psec. The

Until recently, you could choose from very few high-performance oscilloscopes between the \$1700 100-MHz scope and the \$30,000 1-GHz real-time model.

2445A's delay circuitry lets you expand and display any portion of the A-sweep signal, including the A-sweep trigger event itself.

The 150-MHz Kikusui COS6150 is a 5-channel scope. Channels 1 and 2 are full-function channels. The vertical sensitivity controls range from 5V/div to 5 mV/div, and each channel has trace-position controls and AC/GRD/DC selectors. Channel 3's vertical sensitivity control is limited to two positions: 0.1V/div and 1V/div. Besides acting as signal inputs, both channel 4 and channel 5 are used for the external trigger inputs and have a fixed sensitivity of 0.1V/div. You can display the signal CH1+CH2 and data from all five channels at one time on the COS6150.

The COS6150 scope also has an alternate trigger function. If you want to view three signals that are not time-related, you can use the alternate trigger function to get stable displays of the signals. If one of the three inputs doesn't have a signal, the scope bypasses that channel and goes to the next channel to look for its trigger. This feature appears only on the Kikusui scopes.

High sampling rate minimizes data loss

The LeCroy 9400 digital storage oscilloscope acquires data at an effective sample rate of 5G samples/sec and so qualifies as a high-performance scope in spite of the fact that it measures signals only as high as 125 MHz. Each of the 9400's digitizing channels is backed by 32k bytes of memory. (The channels of most other digital



Dual 200-MHz digitizers let you make single-shot measurements to 50 MHz and repetitive-signal measurements to 300 MHz on Hewlett-Packard's 54201A digital storage oscilloscope.

scopes have only 1k byte of memory each.) Despite the machine's large memory, however, the longest waveform you can capture at the 5G-sample/sec rate is only about 6.55 nsec (but the scope does provide 200-psec resolution).

To increase a digital scope's effective bandwidth to a value well above the sampling rate of its A/D converter, manufacturers will incorporate repetitive-sampling techniques in the scope. Hewlett-Packard's Model 54100A, for example, parlays a 40M-sample/sec rate into an effective bandwidth of 1 GHz. LeCroy, however, limits the 9400's effective bandwidth to 125 MHz

TABLE 1—HIGH-PERFORMANCE-OSCILLOSCOPE SELECTION GUIDE

150-MHz TO 250-MHz BANDWIDTH			>250-MHz TO 400-MHz BANDWIDTH		
NONSTORAGE	DIGITAL STORAGE	ANALOG STORAGE	NONSTORAGE	DIGITAL STORAGE	ANALOG STORAGE
HITACHI V-1150	TEKTRONIX 2430		IWATSU SS-5421	HEWLETT- PACKARD 54201A 54201D	TEKTRONIX 7834
IWATSU SS-5712 SS-5321			PHILIPS PM 3290 PM 3295 PM 3296	TEKTRONIX 7854	
KIKUSUI COS6150			TEKTRONIX 485 2465A 2465A CTS 2465A DMS 2465A DVS 2467 7844		
LECROY 9400					
NICOLET 4094B/4175					
PHILIPS PM 3280 PM 3285 PM 3286					
TEKTRONIX 2445A 7704A					

and uses the 5G-sample/sec sample rate to minimize potential errors in waveform reconstruction and timing. At its fastest data-acquisition speed, the 9400 can collect 40 points per cycle on a 125-MHz signal. Therefore, you don't need sine or dot-to-dot interpolators to fill in the missing information.

Wireless remote control speeds programming

Philips's 3280, 3285, and 3286 175-MHz scopes are similar to each other except for a few minor differences. Unlike the 3285 and 3286, the 3280 doesn't have cursors to make ΔT and ΔV measurements. The 3286 is basically a 3285 except that it has an IEEE-488 interface and a TV-style hand-held remote-control unit.

The 3286's remote control stores complete front-panel settings instead of having individual controls that duplicate the controls on the scope itself. You set the measurement and display controls by hand or via the IEEE-488 interface. You then store the setup by pressing the Save button on the remote-control unit. The basic unit lets you save as many as 25 setups; an option lets you save as many as 75. Each setup contains all measurement and display parameters, such as vertical deflection factors, timebase settings, display positions, and trigger levels. To call up a particular setup, you press the Recall button. You can also step through a sequence of setups and delete or insert setups.

All three models have an automatic-setup (or auto-set) feature. When you press the autoset button, the scope will find the beam, place it in the center of the



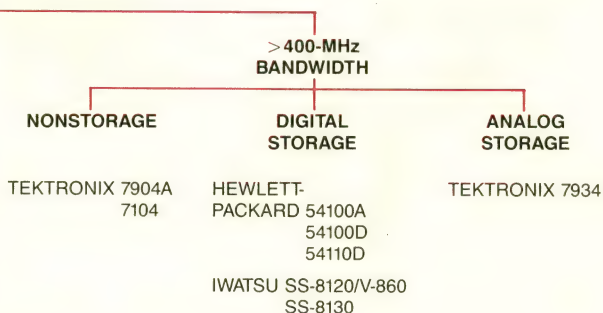
Stable, automatically triggered displays of probed waveforms appear on screen when you press one button on the Tektronix 2465A (350-MHz) and 2445A (150-MHz) analog scopes. The scopes can also store and recall a series of front-panel setups.

screen, and calculate and set the vertical-deflection, timebase, and triggering controls. The settings for the controls are then automatically displayed on the scope's front-panel LCD readouts and LED indicators.

Philips's 350-MHz scopes have all the extra measurement features of the company's 175-MHz scopes. The 350-MHz 3290, 3295, and 3296 have a 10-nsec/div timebase that can be magnified to 1 nsec/div. For single-shot and low-repetition-rate signals, the scopes sport a 4-div/nsec photographic writing speed.

Tektronix's 2465A, an updated version of the 300-MHz 2465, has a bandwidth of 350 MHz, measured at the probe tip. Most scope manufacturers specify a product's bandwidth at the input connector on the scope's front panel. The probes you use with a scope could cause its bandwidth to drop. If you use Tektronix's P6136 probes with the 2465A (two are supplied with each basic instrument), the company guarantees that the instrument will exhibit a 350-MHz bandwidth even at 2-mV/div sensitivity. The 2465A also sports a number of measurement features not found on the earlier version. For instance, it offers an automatic-setup feature that's very similar to the one on Philips's 3280/85/86 and 3290/95/96 series. If you're measuring more than one signal when you press the autoset button on the 2465A, the machine senses which channels are active and correctly formats and displays them on the screen.

The 2465A series also has a front-panel store/recall feature. You set the front-panel controls to the setup you want to save (the position of the on-screen cursors



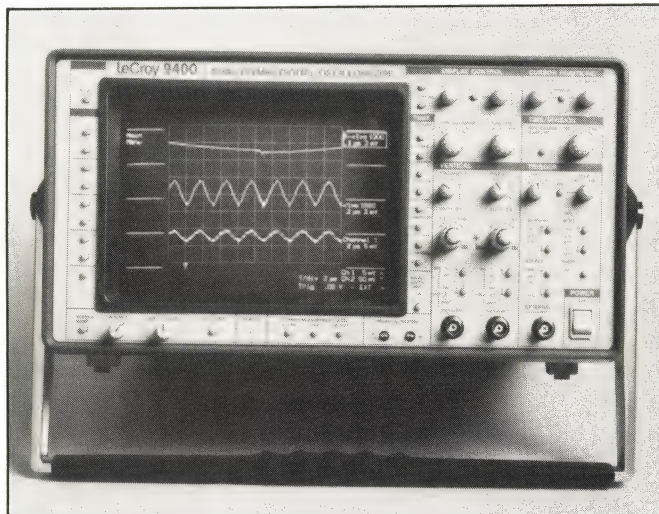
Be careful not to confuse a digital storage scope's bandwidth spec with its effective-bandwidth spec. The latter applies only to repetitive events.

is part of the setup), push the Save button, and enter the file number. You can save as many as eight individual files. To recall a setting, you press the Recall key and enter the file number. You can also store and recall a sequence of settings for semiautomatic test applications. You can store a sequence of as many as 20 different setups and recall them in any programmed order. You can also label each setup. For hands-free operation, you can use an optional foot switch that plugs into the back of the oscilloscope.

Infrequently occurring events made visible

With their high bandwidths and fast rise times, these high-performance scopes can test today's fast logic circuits. To display signals with fast rise times, however, a scope must provide faster sweep speeds. Faster sweep speeds mean that the CRT beam spends less time at a particular point on the screen to excite the phosphor. If you're viewing a signal that has a low repetition frequency, you may find that your scope can't supply enough energy to yield a bright trace.

One solution to the problem is offered by Iwatsu's SS-5421, a 350-MHz, 3-channel scope that offers an enhance mode. When you press the Enhance key, the SS-5421's CRT beam current doubles, increasing the intensity of the trace.

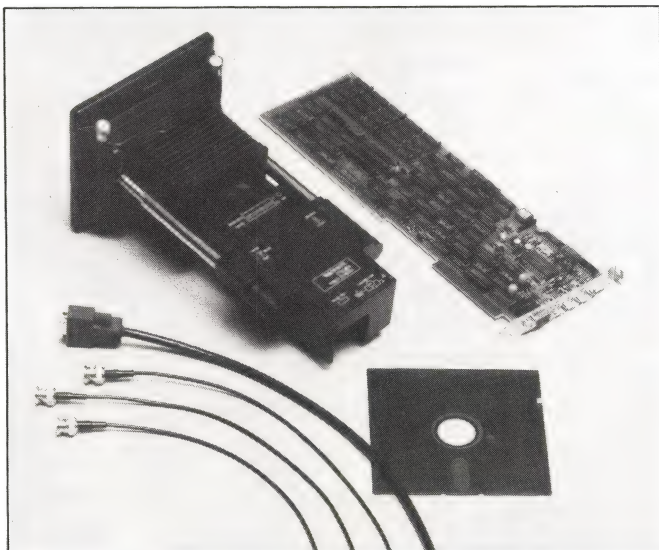


Offering a sampling rate equivalent to 5G samples/sec, the 125-MHz 9400 digital oscilloscope from LeCroy effectively lets you sample a repetitive waveform once every 200 psec.

Tektronix offers another solution to the problem in its 350-MHz Model 2467 (and its 1-GHz Model 7104). Instead of increasing the CRT beam's current to brighten the trace, the 2467 uses a microchannel plate in the CRT tube as an electron multiplier to get more electrons to the phosphor. The microchannel plate itself is located directly behind the CRT screen.

When the CRT electron beam hits the microchannel plate, the electrons enter the closely spaced parallel channels in the plate. The channels are offset at an angle relative to the direction of the beam. Therefore, the entering electrons immediately release secondary electrons. As these secondary electrons move down the channels, they cause additional emissions, which increase the multiplication effect even further. On leaving the channels, the electrons then travel to the CRT screen and excite the phosphor to create a trace. The resulting trace is approximately 1000 times brighter than a trace on a standard CRT.

Not only does the microchannel-plate technique augment dim traces, it also limits bright traces to a comfortable viewing level, preventing them from blooming and preventing the CRT from burning out. When the channels in the microchannel plate are bombarded with a beam that has a high rate of repetition, the channels saturate, limiting the electron-beam current from the microchannel plate to the CRT screen. This feature is important for viewing infrequent events, such as glitches, that are superimposed on highly repetitive events.



You can turn your nonstorage scope into a digital storage system by connecting a digitizing camera system to your scope's face. The C1001 charged-coupled-device (CCD) camera from Tektronix reads the light given off by the CRT phosphor and transmits a video signal to a frame/store card, which is plugged into a PC. The frame/store card digitizes and stores the waveform for analysis and display on the PC.

The 2467 has four channels, a 1-nsec rise time, and a 500-psec/div maximum sweep speed (when you add the X10 magnifier). The 2467 has the same options as those available on the 2445A and 2465A scopes. The autoset and save/recall features are standard on all three instruments.

Camera digitizes your analog scope's display

To save a waveform for post processing, you can use film photography or a charged-coupled-device (CCD) digitizing camera. Tektronix's Digitizing Camera System (\$5395) consists of a CCD digitizing camera plus a frame/store card that plugs into a personal computer. The frame/store card converts the camera signal from analog to digital and stores the resulting data for manipulation and analysis by the PC.

The camera uses Tektronix's C30 Series camera-bezel adapters, so it's compatible with most oscilloscopes, both from Tektronix and from other companies. The camera reads the light given off by the CRT phosphor. When it's used with the 7104, for example, the camera can catch both repetitive and transient events to 1 GHz. The camera system digitizes the trace at an effective sampling rate of 4 psec or 250G samples/sec.

The camera system has full geometric correction routines, including those for correcting lens distortion and CRT electron optic distortion. The camera system also employs procedures that correct for horizontal and vertical linearity. The image-processing technology can extract trace centers from one point in 4096 (ie, it provides 12-bit resolution). The image processor samples the CRT screen's brightness values for each pixel to select one very precise waveform point that is the trace center. The digital camera system's signal resolution is at least 10 times that of the human eye.

The supporting software package for the camera system includes a calibration function that corrects for digitizing errors, a save-on-delta function that sets comparative tolerances for transient analysis of waveforms, and a set of system-maintenance and self-diagnostic functions.

You can also call up waveform-analysis functions to take measurements of rise time, fall time, area under the curve, waveform differential, and delta time. The software allows you to manipulate the displayed waveforms with a zoom feature; the graphic routines let you add titles to waveforms.

Although it's a bit bulky, the digital-camera system gives analog scopes some of the advantages of digital



This handheld IR remote control unit used with the 350-MHz PM 3296 from Philips lets you recall as many as 25 front-panel setups.

storage scopes—the PC displays have a constant intensity, and the digital-camera system keeps a digital record of a waveform.

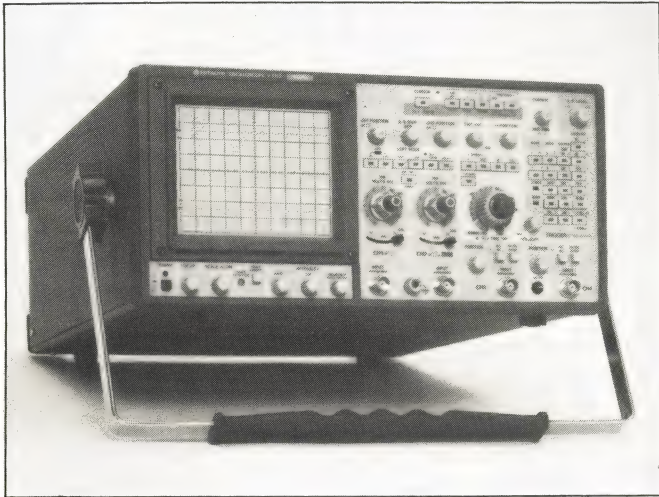
Digital storage scopes

If you're looking for a high-performance digital storage oscilloscope, you'll be happy to find that these scopes offer both higher bandwidths and lower prices than before. Digital storage scopes have two bandwidth specifications: one for acquiring a single-shot or single-pass event and one (effective bandwidth) for acquiring repetitive events. The machine's bandwidth for single-shot waveforms will be lower. When you review the bandwidth specification for a digital storage scope, then, be sure that you know whether the spec refers to the scope's single-shot bandwidth or its effective bandwidth. Because the single-shot bandwidth of a scope depends on the signals you measure and the interpolators, if any, that the oscilloscope provides, many scope manufacturers will not even provide a bandwidth spec; instead, they'll give you only the digitizer's sample rate and let you determine the bandwidth yourself.

Until two or three years ago, most digital storage scopes used a real-time digitizing scheme to sample incoming waveforms. A real-time digitizing scope collects all its data points during a single pass of the incoming waveform; it doesn't collect additional data points during repeated passes of the waveform. Assuming the scope's analog circuitry has an adequate bandwidth, the scope's bandwidth is directly related to the sampling rate of its digitizer.

Theoretically, the highest bandwidth a real-time

To save a waveform for post processing, you can use film photography or a charged-coupled-device (CCD) digitizing camera.



A built-in frequency counter, a digital multimeter, and on-screen cursors for ΔT and ΔV measurements add to the productivity of Hitachi's 150-MHz, 4-channel, 8-trace oscilloscope.

digitizing scope could have would be 50% of the sampling rate. Realistically, however, real-time digitizing scopes have bandwidths that are 10% to 40% of their digitizers' sampling rates. Today's oscilloscope digitizers are limited to sampling rates of 100M to 200M samples/sec. As a result, the bandwidths of real-time digitizing scopes are limited to below 50 MHz, which is not adequate for most design engineers' needs.

Repetitive sampling boosts bandwidth

Manufacturers solve this problem in modern digitizing oscilloscopes by employing repetitive-sampling techniques. These techniques increase a scope's bandwidth above its digitizer's sample rate. Two repetitive-sampling techniques currently exist in digital scopes: sequential sampling and random sampling. The techniques apply only to repetitive waveforms; they don't work with single-shot events.

Iwatsu's SAS-8130 waveform analyzer uses the sequential-sampling technique. When triggered, the SAS-8130 takes one sample of data during the first pass of the waveform. During the second pass, the analyzer inserts a small delay and takes a second sample. During the third pass, the analyzer inserts another delay and takes a third sample. Although the scope samples data at 70k samples/sec, the effective bandwidth is 3.5 GHz or 12.4 GHz, depending on which sampling head you use. The vertical resolution is 10 bits.

The SAS-8130 has a number of built-in measurement functions that take time and voltage measurements and perform waveform searches and autoranging. You can

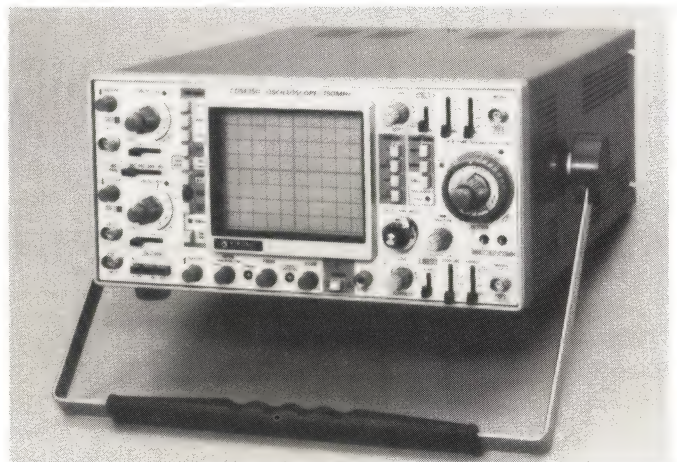
store as many as 15 sets of measurement functions, or programs, and call them up one at a time or have the analyzer automatically sequence through the programs.

Display modes increase scope productivity

Because the SAS-8130 uses only the sequential-sampling technique, you can't use it to view single-shot events. Tektronix's 2430 digital scope, however, employs both real-time sampling and sequential sampling, so you can capture both single-shot events and repetitive events with bandwidths as great as 150 MHz. The scopes use two CCD-based digitizers that operate to 100M samples/sec with 8-bit resolution. The 2430's single-shot bandwidth can be 40 MHz when you use the internal, modified sine x/x interpolator.

The 2430 can also catch and display single-shot glitches as short as 2 nsec. Instead of relying on the digitizers to detect the glitches, the 2430 uses a custom-designed peak detector. The glitch-detecting hybrid circuit actually consists of several detectors. When an input signal enters the scope, the signal is split into two signals of opposite polarity, which go directly to two positive and two negative detectors. The pairs of peak detectors are very useful: One of each pair can detect peaks while the other is tracking or being sampled. This way, the machine can detect glitches that didn't occur at the instant the input signal was sampled.

For the glitch-capture circuitry to operate, the machine must be in the envelope storage mode. In this mode, the 2430 records and displays only the minimum

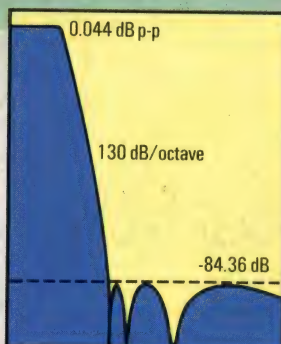


You can view five channels of 150-MHz data at a time on Kikusui's COS6150 oscilloscope. The COS6150's alternate trigger function provides stable triggering even when the input signals are not time-related.

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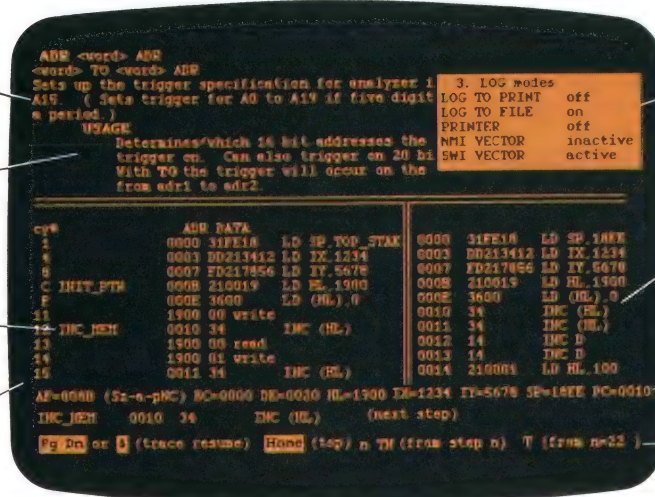
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Symbol translation or source code line display.

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High-performance digital scopes all use repetitive-sampling techniques to increase their bandwidths above their digitizers' sample rates.

and maximum waveform values detected over one or more sweeps. The envelope mode makes the 2430 useful for monitoring signal frequency and amplitude drift, or for finding pulse dropouts or extraneous pulses.

The 2430 also has an acquisition mode where you define the waveform envelope. After you've defined the waveform's envelope, the 2430 will continuously take readings until part of the incoming waveform falls outside the envelope. The 2430 then stops and saves the waveform. This capability is useful for finding intermittent glitches or failures.

Hewlett-Packard's 54201A and 54201D scopes also feature an envelope display and an accumulate mode. When they're in the accumulate mode, the scopes display all successive waveform acquisitions until you erase them. If the incoming signal exhibits a glitch condition or a metastable situation, the accumulate mode will detect it.

The 54201A and 54201D are 300-MHz repetitive-bandwidth scopes. The two models differ in their triggering capabilities. The 54201A has a single external analog trigger input. The 54201D lets you trigger on logic-state events, much as you do with a logic analyzer. You can ask the 54201D to trigger after it detects a sequence of four words. The first three trigger words can be as many as 27 bits long. The last trigger condition can consist of four 27-bit words that are ORed or ANDed and have occurred a specified number of times. After all the conditions are met, the 54201D can either trigger immediately or wait for the next analog trigger condition before triggering. You can also set the 54201D to trigger on a missing bit in a string of serial data, or to trigger when an extra bit has been added to the string.

Both models have onscreen cursors that let you make time and voltage measurements. You can measure the time between two data points to within 200 psec. Both units automatically take measurements of frequency, period, pulse width, and transition time, as well as a number of delay and voltage measurements, every time a recording is made or a waveform is called up from memory.

One of the key advantages that a real-time digital storage oscilloscope has over an analog scope is the ability to record and display data that occurs before the trigger. Digital storage scopes that use the sequential-sampling technique don't have this advantage; although they have higher bandwidths than do their real-time counterparts, they can't save pretrigger data.



Able to sample and display a repetitive 12.5-GHz waveform, Iwatsu's SAS-8130 waveform analyzer lets you use the keyboard to direct the digital scope to make time and voltage measurements, perform waveform searches, and store and recall measurement programs.

To allow its digital sampling scopes to retain pretrigger data, Hewlett-Packard uses random-repetitive-sampling technology. As with sequential sampling, random repetitive sampling works only with a repetitive waveform. However, unlike machines that perform sequential sampling, scopes that use random sampling don't control the time between the trigger and the sample points: This time is random. The scope can measure the interval between the collected sample points and the trigger, however. Because the scope can't tell whether it's measuring the time from a sample point to the trigger (pretrigger data) or from the trigger to a sample point (post-trigger data), it can save both pretrigger and post-trigger data.

Further, a random-sampling scope's bandwidth is not limited by its sampling rate, because the trace is built up from data taken from a number of passes of the waveform. The bandwidth depends on the scope's analog front-end circuitry and its track/hold circuit.

Employing the random-sampling technique are Hewlett-Packard's 54201A and 54201D, which have a 300-MHz effective bandwidth, and the company's 54100 series, which has an effective bandwidth of 1 GHz. The 54100 series, which comprises three models (the 54100A, the 54100D, and the 54110D), offers a 350-psec rise time. These scopes can trigger on pulses as narrow as 1 nsec. You can display waveforms with sweep speeds of 100 psec/div and make timing measurements with 10-psec resolution.

The 54100D and 54110D differ from the 54100A in that, like the company's 54201D oscilloscope, they trig-

Analog storage scopes are still essential for capturing high-speed single-shot events.

ger the way a logic analyzer does. The 54110D has a color display, and it also has some capabilities not found on the 54100D. For example, the 54110D lets you add or subtract either channel's data from the other, so you can make differential measurements. It also allows you to display an X-Y plot (for making high-speed I-V measurements, for example).

The scope lets you automate time-delay measurements between events occurring on two separate data paths by programming the voltage cursors to seek out the 50% points on the displayed waveforms. The scope then automatically displays the resulting time-interval measurement.

Each of the three models has six waveform memories, two of which are pixel memories. You can store any number of waveforms in them. The remaining four memories can each store one waveform, and you can recall the waveforms for post-acquisition data measurement and data manipulation.

Now that digital storage scopes offer 1-GHz bandwidths, you may wonder whether analog storage scopes are still useful. They are—they're essential for capturing high-speed single-shot events. Remember that digital storage scopes with bandwidths above 50 MHz all depend on being able to sample multiple passes of a waveform; they can't capture a high-speed single-shot event.

To capture a high-frequency single-shot phenomenon, you can use Tektronix's 7834 400-MHz analog storage scope or 7934 500-MHz scope. The 7934 has a 700-psec single-shot rise-time storage capability, and it features a 4-cm/nsec writing speed when it's in fast-variable-persistence mode and the display area on the CRT is reduced.

When the scope's in this mode, a waveform appears

within a 3.6×4.5-cm grid in the center of the screen, and the display remains visible for approximately 30 seconds. If you are storing signals with lower bandwidths, you can use one of several other storage modes. The bistable mode, for example, gives you at least 30 minutes of viewing time. By pressing the Save button, you can extend the viewing time to several hours. The 7934, with its 500-MHz bandwidth, is the fastest direct-storage scope available today.

If you need to view faster single-shot phenomena, you must turn to the scan-tube-conversion technology of Tektronix's 7250 oscilloscope. The 7250 has a 6-GHz bandwidth and a 50-psec rise time. It has programmable sweep delay and 14 sweep speeds from 1 to 50 psec/div. You can use an external generator to provide a sinusoidal (Rossi) sweep capability to 3 GHz. You must use the 7250 with an external trigger and with a 50-nsec pretrigger pulse.

After storing the waveform on the scan tube, the scope digitizes the waveform. The digitizer has 11 bits of vertical resolution and nine bits of horizontal resolution. You can store as many as 15 acquisitions in internal memory. The 7250 also has onscreen cursors for waveform measurement. Its waveform-processing capabilities perform data correction, filtering, and smoothing.

Although it will be a long time before digital storage oscilloscopes reach the performance level of the 7250, in the near future you can expect to see digital storage scopes whose digitizers can reach speeds on the order of 1G sample/sec.

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Article Interest Quotient (Circle One)
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Manufacturers of high-performance oscilloscopes

For more information on high-performance oscilloscopes, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

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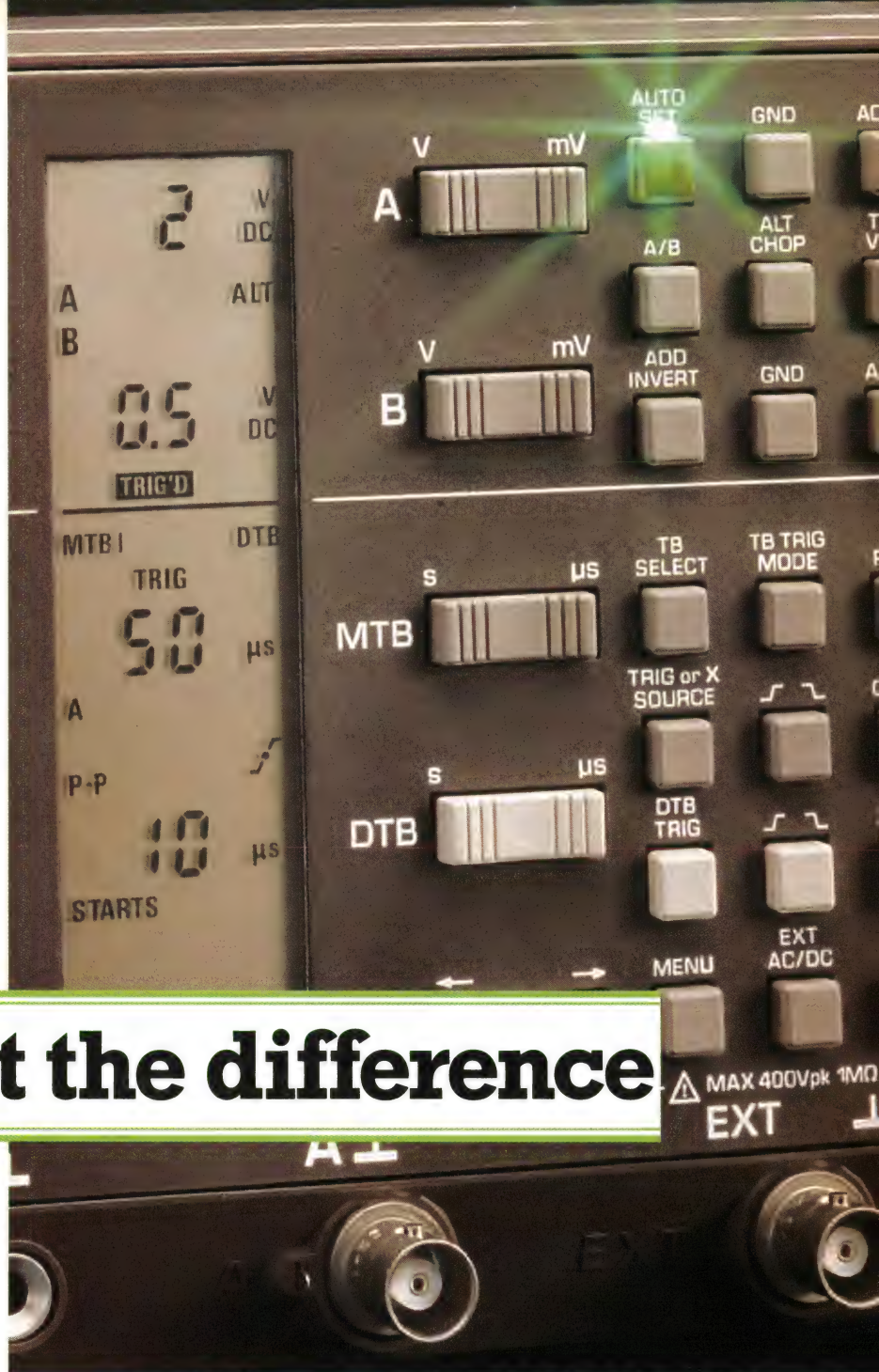
Take a look at these unique benefits:

- **AUTO-SET** facility and **LCD Status/Setting** panel for optimal signal setting and instant display of all signal parameters.

- **Extremely high performance** and specification thanks to special features like: 16 kV CRT unit, versatile triggering functions up to 100 MHz, plug-in system modularity and extensive use of IC microelectronics.

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100 MHz
200 MHz
500 MHz
1 GHz



Anti-aliasing enhances measurement confidence. Signal distortion (sample mode only) is shown at high frequencies (top). The peak detect mode displays peak information without signal distortion (bottom).

INTRODUCING TWO DIGITAL STORAGE SCOPES WITH SOME MIGHTY IMPRESSIVE NUMBERS.

From 4K record length to 20 MS/s sampling at 100 MHz or 60 MHz... our two new scopes have just what you're looking for! The 2230 and 2220 are powerful digital storage oscilloscopes—and the first scopes in their class that include non-storage capability to these bandwidths.

You can reference, compare, and analyze waveforms with digital storage convenience, plus the confidence you get with analog measurements. Simply switch to the non-store mode to view the signal that the scope has digitized. Only Tek offers this flexibility to 100 MHz and 60 MHz in affordable scopes.

Enhancing use of the scopes as design and troubleshooting tools are fast sample and hold detector circuits, plus the proprietary peak detect mode. They enable the display of pulses as narrow as 100 ns at any sweep speed—even on a single sweep.

You'll also find such features as post-acquisition expansion and compression, X-Y capability to each scope's storage bandwidth and, for systems use, optional GPIB or RS-232-C interfaces.

Best of all, the 2220 and 2230

Features	2230	2220
Analog/Digital Storage Bandwidth	100 MHz	60 MHz
Single Shot (Transient) B.W. (10 points per signal period)	2 MHz	2 MHz
Maximum Sampling Speed	20 MS/s	20 MS/s
Record Length	4K/1K (selectable)	4K
Save Reference Memory	One, 4K Three, 1K	One, 4K
Vertical Resolution	8 bit 10 bit (avg mode)	8 bit
Peak Detect	Yes (100 ns)	Yes (100 ns)
Averaging	Yes (menu-selectable)	Yes (rep. sampling)
X-Y Storage Bandwidth	100 MHz	60 MHz
GPIB/RS-232-C Options	Yes (talker/listener, includes 26K of battery-backed memory)	Yes (talker/listener)
Price	\$5150	\$4150

are easy to use and afford. And backed by Tek's famous 3-year warranty that includes the CRT. Check the front panels. The controls are familiar, comfortable, easy to identify. Designed to push productivity and minimize training time.

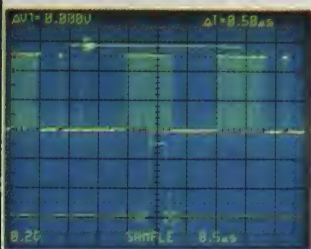
In the 2230, CRT readout of front panel settings and key parameters means even more convenience, with cursors for waveform voltage and timing measurements.

Get the reliability and performance you expect in Tek scopes, now enhanced by digital storage, at unexpected prices: \$4150 for the 2220, \$5150 for the 2230.

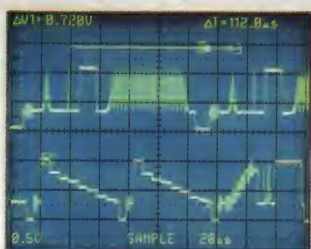
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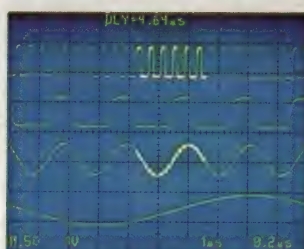
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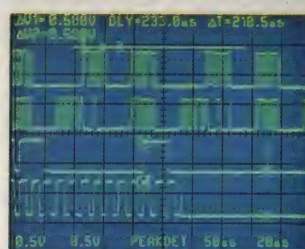
On-screen viewability lets you expand, compress, and position waveforms saved in reference memory. This permits easy viewing and display flexibility of up to eight saved waveforms.



High display resolution and accuracy permits on-screen viewing of signals such as the TV test signal shown here. 4K of record information can be viewed in 1K windows.



100 MHz, non-storage capability comes standard in the 2230. In addition, there's dual channel, dual timebase, versatile triggering and CRT readout.



The 2230 offers the convenience of CRT readout in both storage and non-storage modes at 100 MHz. Storage mode cursors make ΔV , ΔT , and $1/\Delta T$ measurements fast and easy.

Tektronix®
COMMITTED TO EXCELLENCE

TABLE 2—HIGH-PERFORMANCE OSCILLOSCOPES

COMPANY	MODEL NUMBER	ANALOG BANDWIDTH (MHz)	NUMBER OF INPUT CHANNELS ¹	MINIMUM VERTICAL DEFLECTION FACTOR ² (mV/DIV)	NONSTORAGE OPERATION		ANALOG STORAGE OPERATION	DIGITAL STORAGE OPERATION		
					MAXIMUM TIMEBASE SWEEP RATE ³ (nSEC/DIV)	DUAL TIMEBASE	MAXIMUM WRITING SPEED (DIV/nSEC)	MAXIMUM DIGITIZING RATE (M SAMPLES/SEC)	EQUIVALENT TIME SAMPLE-MODE BANDWIDTH (MHz)	VERTICAL RESOLUTION (BITS)
HEWLETT-PACKARD	HP54201A	300	2	5	—	—	—	200	300	6
	HP54201D	300	2	5	—	—	—	200	300	6
	HP54100A	1000	2	10	—	—	—	40	1000	7
	HP54100D	1000	2	10	—	—	—	40	1000	7
	HP54110D	1000	2	10	—	—	—	40	1000	7
HITACHI	V-1150	150	2+2	2	20	YES	—	—	—	—
IWATSU	SS-5712	200	2+2	5	10	YES	—	—	—	—
	SS-5321	250	2+1	5	10	YES	—	—	—	—
	SS-5421	350	2+1	5	10	YES	—	—	—	—
	55-8120/V-860	1000	4	2	—	—	—	—	1000	—
	SAS-8130	12,400	2	2	—	—	—	0.07	12,400	10
KIKUSUI	COS6150	150	2+1+2	10	20	YES	—	—	—	—
LECROY	9400	125	2	5	—	—	—	100	125	8
NICOLET	4094B/4175	100	2	5	—	—	—	50	100	8
PHILIPS	PM 3280	175	2+1	1	20	YES	2	—	—	—
	PM 3285	175	2+1	1	20	YES	2	—	—	—
	PM 3286	175	2+1	1	20	YES	2	—	—	—
	PM 3290	350	2+1	1	10	YES	4	—	—	—
	PM 3295	350	2+1	1	10	YES	4	—	—	—
	PM 3296	350	2+1	1	10	YES	4	—	—	—

	SAMPLE MEMORY (WORDS)	AUTOMATED MEASUREMENTS	WEIGHT (LBS)	BASE PRICE	COMMENTS
	1001	AUTOMATIC WAVEFORM, ΔT , ΔV	25	\$7900	AUTOSCALE FEATURE AUTOMATICALLY PROVIDES A SCALED DISPLAY OF THE INPUT. YOU CAN STORE FOUR MEASUREMENT SETUPS IN MEMORY
	1001	AUTOMATIC WAVEFORM, ΔT , ΔV	28	\$9800	HAS SAME FEATURES AS THOSE OF 54201A PLUS LOGIC-ANALYZER-LIKE TRIGGERING CAPABILITY
	1024	AUTOMATIC WAVEFORM, ΔT , ΔV	42	\$17,600	THE PRESENT CAPABILITY AUTOMATICALLY PROVIDES A SCALED DISPLAY FOR EITHER TTL OR ECL. YOU CAN STORE AS MANY AS 10 MEASUREMENT SETUPS. YOU CAN SET THE DISPLAY'S TIMEBASE TO 100 pSEC/DIV AND MAKE TIMING MEASUREMENTS TO 10-pSEC RESOLUTION
	1024	AUTOMATIC WAVEFORM, ΔT , ΔV	42	\$19,300	HAS SAME FEATURES AS THOSE OF 54100A PLUS LOGIC-ANALYZER-LIKE TRIGGERING CAPABILITY
	1024	AUTOMATIC WAVEFORM, ΔT , ΔV	56	\$21,100	HAS SAME FEATURES AS THOSE OF 54100D PLUS COLOR DISPLAY
	—	FREQUENCY, DC AND AC VOLTAGES, ΔT , ΔV	22	\$2950	YOU CAN PLACE TWO LINES OF COMMENTS ON THE DISPLAY
	—	—	25	\$2999	CAN TRIGGER ON A 4-BIT WORD WHEN YOU USE THE OPTIONAL COMBINATION TRIGGER PROBE
	—	—	24	\$3995	YOU CAN MAGNIFY TIMEBASE SWEEP RATE TO 1 nSEC/DIV
	—	—	24	\$6950	HAS SAME FEATURES AS THOSE OF SS-5321
	—	—	45	\$12,390	V-860 VERTICAL SECTION TO TAKE TIME-DOMAIN-REFLECTOMETRY (TDR) MEASUREMENTS. YOU ADD A DIGITAL MEMORY TO USE THE SS-8120 AS A 4-CHANNEL 1-GHz SCOPE
	1024	ΔT , ΔV , AVERAGING	53	\$25,500	YOU CAN STORE AS MANY AS 15 MEASUREMENT PROGRAMS. EACH PROGRAM CAN INCLUDE COMMENTS, FRONT-PANEL SETUPS, AND MEASUREMENT AND MATH OPERATIONS
	—	—	22	\$2295	
	32,768	ΔT , ΔV	30	\$9900	THE 9400 HAS AN EQUIVALENT SAMPLING RATE OF 5G SAMPLES/SEC (OR ONE SAMPLE POINT EVERY 200 pSEC)
	16,384	TIME, VOLTAGE, ΔT , ΔV	37	\$15,400	THE 4094 HAS AN EQUIVALENT SAMPLING RATE OF 500M SAMPLES/SEC (OR ONE SAMPLE POINT EVERY 2 nSEC)
	—	—	30	—	THE AUTOSSET FEATURE PROVIDES FOR BOTH THE INSTANTANEOUS SETTING OF ALL CONTROLS FOR INITIAL MEASUREMENTS AND THE RETRIEVAL OF ANY OFF-SCREEN TRACES
	—	ΔT , ΔV	30	\$4400	PM 3285 ALSO INCLUDES AUTOSSET FEATURE
	—	ΔT , ΔV	30	\$5400	SAME FEATURES AS THOSE OF THE PM 3285, PLUS IEEE-488 INTERFACE AND INFRARED REMOTE CONTROLLER
	—	—	31	\$4750	THE AUTOSSET FEATURE PROVIDES FOR BOTH THE INSTANTANEOUS SETTING OF ALL CONTROLS FOR INITIAL MEASUREMENTS AND RETRIEVAL OF ANY OFF-SCREEN TRACES
	—	ΔT , ΔV	31	\$5150	PM 3295 ALSO INCLUDES AUTOSSET FEATURE
	—	ΔT , ΔV	31	\$6400	SAME FEATURES AS PM 3295 PLUS IEEE-488 INTERFACE AND INFRARED REMOTE CONTROL

Table continued on pg 150

TABLE 2—HIGH-PERFORMANCE OSCILLOSCOPES (Continued)

COMPANY	MODEL NUMBER	ANALOG BANDWIDTH (MHz)	NUMBER OF INPUT CHANNELS ¹	MINIMUM VERTICAL DEFLECTION FACTOR ² (mV/DIV)	NONSTORAGE OPERATION		ANALOG STORAGE OPERATION	DIGITAL STORAGE OPERATION		
					MAXIMUM TIMEBASE SWEEP RATE ³ (nSEC/DIV)	DUAL TIMEBASE	MAXIMUM WRITING SPEED (DIV/nSEC)	MAXIMUM DIGITIZING RATE (M SAMPLES/SEC)	EQUIVALENT TIME SAMPLE-MODE BANDWIDTH (MHz)	VERTICAL RESOLUTION (BITS)
TEKTRONIX	2430	150	2+2	2	—	—	—	100	150	8
	2445A	150	2+2	2	10	YES	—	—	—	—
	7704A/7A24/7B85	250	2	10	10	YES	—	—	—	—
	485	350	2	5	1	YES	—	—	—	—
	2465A	350	2+2	2	5	YES	—	—	—	—
	2465A CTS	350	2+2	2	5	YES	—	—	—	—
	2465A DMS	350	2+2	2	5	YES	—	—	—	—
	2465A DVS	350	2+2	2	5	YES	—	—	—	—
	2467	350	2+2	2	0.5	YES	—	—	—	—
	7834/7A19/7B80/7B85	400	1	10	10	YES	2.8	—	—	—
	7844/7A24/7B85	400	2	20	10	YES	—	—	—	—
	7854/7A24/7B87	400	2	5	10	NO	—	0.5	400	10
	7904A/7A29/7B92A	500	1	10	0.5	YES	—	—	—	—
	7934/7A29/7B92A	500	1	10	0.5	YES	4.4	—	—	—
	7104/7A29/7B10/7B15	1000	1	10	2	YES	—	—	—	—
	7250	6000	1	400	0.05	NO	—	—	6000	11

NOTES:

1. THE FIRST NUMBER SPECIFIES THE NUMBER OF INDEPENDENT INPUT CHANNELS, THE MIDDLE NUMBER (OF THREE) SPECIFIES THE NUMBER OF INDEPENDENT INPUT CHANNELS THAT OFFER LIMITED VERTICAL ATTENUATION, AND THE LAST NUMBER (OF TWO OR THREE) SPECIFIES THE NUMBER OF ADDITIONAL INPUT CHANNELS THAT SHARE CONNECTORS WITH THE EXTERNAL TRIGGER CIRCUITRY (TRIGGER-VIEW CHANNELS)
2. THIS SPECIFICATION DOES NOT INCLUDE VERTICAL MAGNIFICATION
3. THE FASTEST SWEEP RATE FOR THE SWEEP-A TIMEBASE WITHOUT SWEEP MAGNIFICATION

	SAMPLE MEMORY (WORDS)	AUTOMATED MEASUREMENTS	WEIGHT (LBS)	BASE PRICE	COMMENTS
	1024	TIME, VOLTAGE, ΔT , ΔV	24	\$8900	YOU CAN SAVE ONLY THOSE SIGNALS THAT EXCEED A PREDEFINED REFERENCE OR ENVELOPE
	—	ΔT , ΔV	—	\$3590	IEEE-488 INTERFACE, 150-MHz TIMER/COUNTER, 17-BIT TRIGGER-WORD RECOGNIZER, TV WAVEFORM MEASUREMENT SYSTEM, AND 4½-DIGIT AUTORANGING DMM ARE OPTIONAL. THIS RECENTLY INTRODUCED MODEL ALSO HAS SINGLE-BUTTON SETUP, SAVE/RECALL SETUP MEMORY, SETUP SEQUENCING, AND SETUP TRANSFERS WITHOUT A CONTROLLER
	—	—	> 30	\$9480	WHEN YOU ADD THE APPROPRIATE PLUG-IN MODULE, THE 7704A MAINFRAME CAN HAVE A CALIBRATED SWEEP RATE OF 2 nSEC/DIV
	—	—	21	\$9100	
	—	ΔT , ΔV	30	\$5350	THIS RECENTLY INTRODUCED MODEL INCREASES THE 2465'S BANDWIDTH FROM 300 MHz TO 350 MHz AND ADDS SINGLE-BUTTON SETUP, SAVE/RECALL SETUP MEMORY, SETUP SEQUENCING, AND SETUP TRANSFERS BETWEEN SCOPES WITHOUT A CONTROLLER
	—	ΔT , ΔV , TIME, FREQUENCY	30	\$7150	THE 2465A CTS INCLUDES ALL OF THE 2465A'S FEATURES, PLUS GPIB, A TIMER/COUNTER, AND A 17-BIT TRIGGER-WORD RECOGNIZER
	—	ΔT , ΔV , TIME, FREQUENCY, VOLTAGE, AMPS, dBm, dBV, OHMS	30	\$8400	THE 2465A DMS IS A 2465A WITH A MULTIFUNCTION 4½-DIGIT DMM
	—	ΔT , ΔV , TIME, FREQUENCY, VOLTAGE, AMPS, dBm, dBV, OHMS	30	\$9200	THE 2465A DVS IS A 2465A DMS WITH THE ADDITIONAL CAPABILITY OF TRIGGERING ON TELEVISION WAVEFORMS
	—	ΔT , ΔV , FREQUENCY, VOLTAGE RATIO, DUTY FACTORS	21	\$11,900	THE 4-DIV/nSEC VISUAL WRITING RATE LETS YOU VIEW INTERMITTENT EVENTS THAT ARE SUPERIMPOSED ON REPETITIVE SIGNALS
	—	—	—	\$19,705	THE 7834 LETS YOU STORE A 1.4-nSEC SINGLE-SHOT EVENT
	—	—	> 36	\$19,480	7844 IS A DUAL-BEAM OSCILLOSCOPE DESIGNED FOR CAPTURING SINGLE-SHOT EVENTS. ITS PHOTOGRAPHIC WRITING SPEED IS 1.5 CM/ μ SEC
	1024	ΔT , ΔV , TIME, VOLTAGE, MATH OPERATIONS	> 45	\$20,220	YOU CAN ADD A SAMPLING PLUG-IN MODULE FOR TIME-DOMAIN-REFLECTOMETRY OR REPETITIVE-SIGNAL MEASUREMENTS TO 14 GHz
	—	—	> 37	\$16,625	
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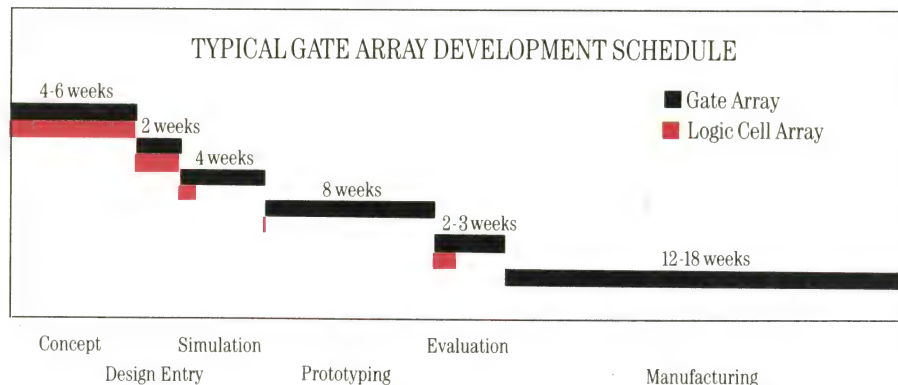
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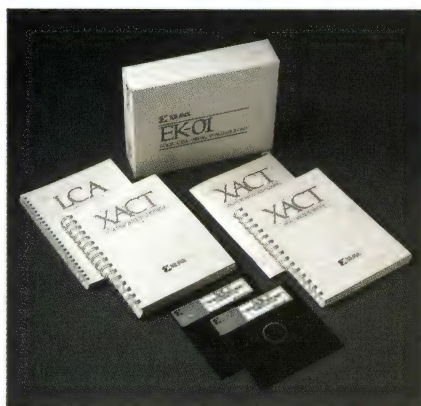


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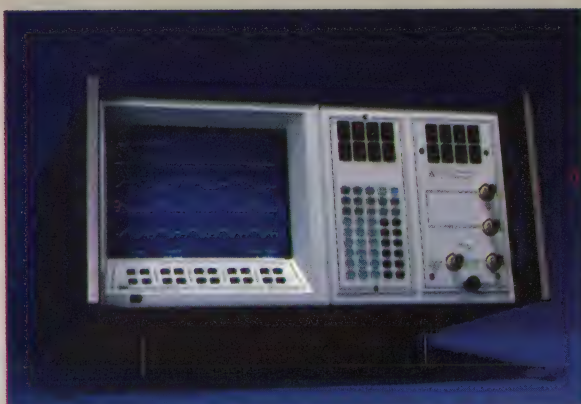
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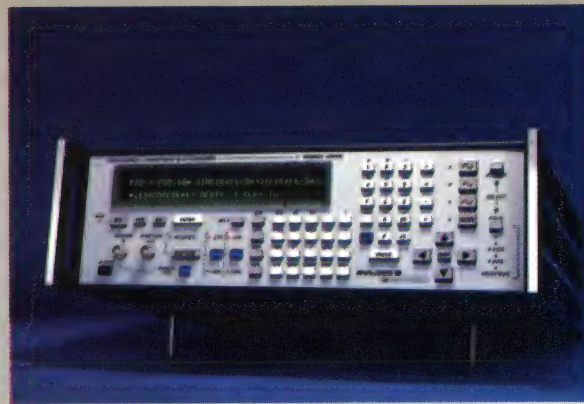
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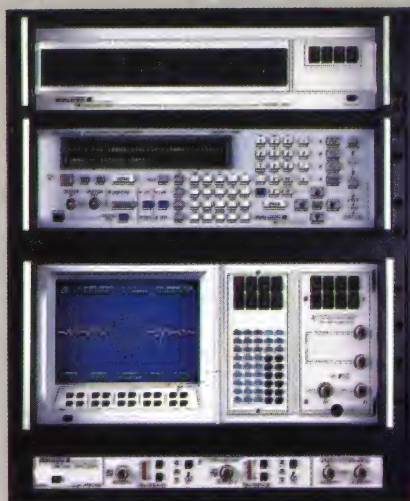
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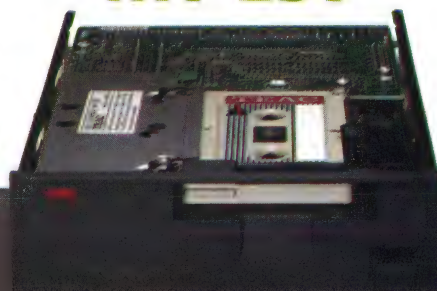
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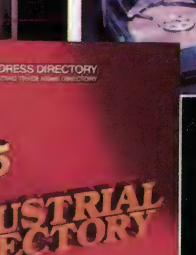
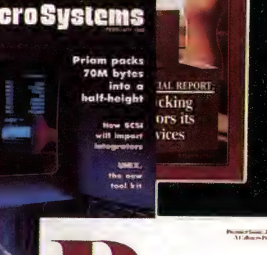
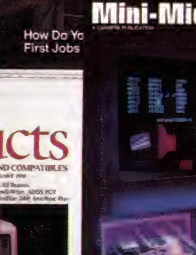
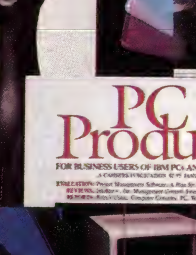
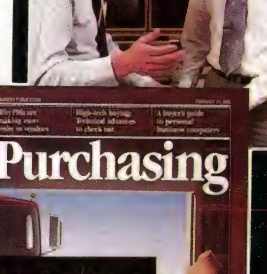
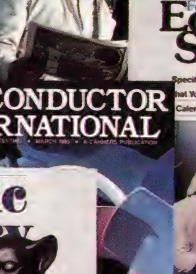
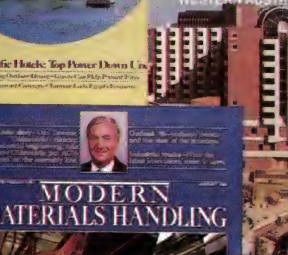
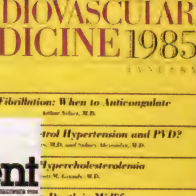
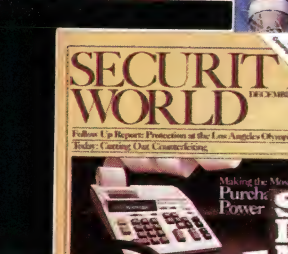
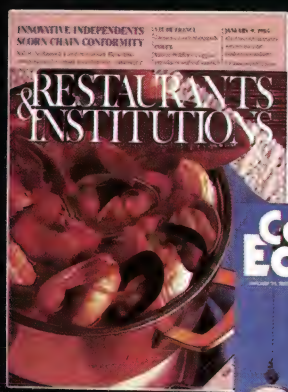
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Word generators bring order to logic testing

Logic analysis no longer entails just using a logic analyzer. A logic analyzer isn't a comprehensive solution to logic testing. Given the complexity of today's circuitry, you have to complement an analyzer with a word generator if you want to systematically test logic circuits.

Robert Delp and Peter Kleindienst,
Dolch Logic Instruments

Systematic test methods and systematic use of test equipment are routine practice in the analog world. For example, no analog designer would ever search for an error in an audio amplifier using just an oscilloscope—he or she would use a signal generator to provide a defined input so that the scope readings would have some meaning.

Surprisingly, this systematic testing approach hasn't carried over into the digital world. Although the word generator—the digital equivalent of the signal generator—has been available for some time, digital designers seldom use it.

A look at word-generator operation

A word generator is a digital signal source that serves as a stimulus for a circuit. You can best describe a word generator's function as that of a logic analyzer in reverse. Whereas a logic analyzer stores a number of

input signals in memory for subsequent analysis, a word generator produces the previously defined contents of its memory. A word generator can produce data in manually controlled single steps, as a single sequence or burst, or as a repeating sequence. Finally, the requirements of today's complex digital circuitry require that the generator's logic-output levels be selectable, that it provide a high-impedance switching option (3-state); and that it be able to interact (handshake) with the system under test.

In analog technology, a signal generator provides a defined signal (sine, delta, or square wave) to the circuit under test. You then use an oscilloscope to

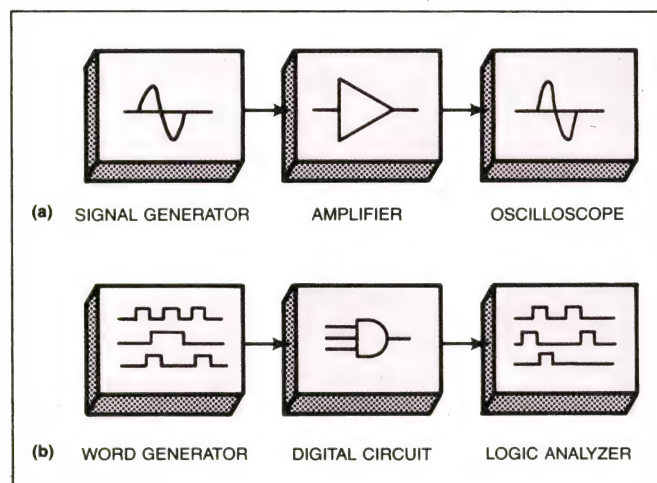


Fig 1—To develop a useful test program, analog-system designers rely on the signal generator to provide a defined input signal and an oscilloscope to measure the test circuit's effect on this test signal (a). Digital designers would do well to follow a similar procedure, substituting a word generator for the signal generator and a logic analyzer for the oscilloscope (b).

Regardless of the level of complexity, you can always use the input signals to define the output of a digital circuit.

evaluate the signal at the test-circuit output (Fig 1a). In digital technology, a word generator replaces the signal generator and provides a predefined bit pattern to the inputs of the circuit under test. You then use a logic analyzer to record the circuit's reaction to this stimulation (Fig 1b).

For some reason, digital designers seldom apply practical analog-technology testing techniques. Quite often, you'll see a digital designer using only a logic analyzer to attempt to explain curious circuit behavior that could well be caused by a combination of software and hardware problems. Envisioning a comparable situation in the analog domain provides a glimpse of the havoc that could result: Imagine trying to determine the harmonic distortion of an audio amplifier by simply using a record as an undefined signal source. Realistically, analog technology dictates that you develop a legitimate test procedure by first tracing the hardware function with the help of a defined input source—a signal generator.

The requirement is no different in the digital world. Before you can expect your system to process the appropriate software, you must first trace its hardware function using systematic test methods. Although digital functions are often far more complicated than analog functions, a precise definition of a digital circuit's reaction to particular input signals is possible. A test sequence for a 3-to-8 binary decoder will illustrate this point.

First, consider investigating the circuit's output behavior by using a pseudorandom input signal from a second hardware module. With this technique, it isn't apparent whether the circuit under test is behaving correctly or not (Fig 2a).

Word generator has big advantage

The situation changes entirely when you use a word generator to produce precisely defined input signals (Fig 2b). Because the word generator can supply a binary number to the input that progressively increments upward, the ladder pattern at the outputs immediately shows the malfunction of the circuit at output 0. The pseudorandom input signals totally mask this same malfunction in Fig 2a.

In the real world, of course, digital circuits are far more complicated than the 3-to-8 decoder in the preceding example. However, the example does serve to demonstrate how important it is to develop a test scheme that relies on a systematic circuit simulation. It's essential to realize that you can describe the output

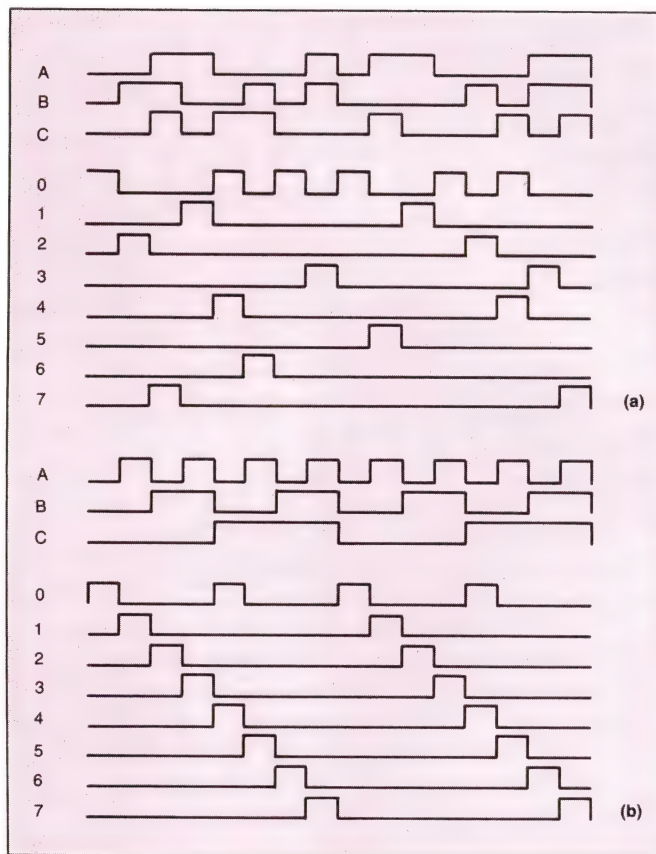


Fig 2—Using pseudorandom input signals to test digital circuitry can easily mask true circuit performance (a). When you use a word generator to produce a well-defined input (b), the test sequence readily shows the error.

of the most complex circuit as a function of the input. Once you systematically evaluate the hardware's basic function, it's a simple matter to integrate the software with the hardware.

In addition to providing well-defined input signals, word generators offer a most important advantage when it comes to developing a test sequence: They allow you to detect errors quickly by providing you with a profile of a circuit's theoretical function. You can then compare this profile with the circuit's actual performance. To illustrate how the word generator can help, consider the following scenario:

You're working on a project involving independently developed digital modules X and Y (Fig 3a). Unfortunately, technical difficulties delay the development of module X, but you can't test module Y separately because it can only function when working in tandem with module X. This predicament presents a perfect application for the word generator. You simply use the

generator to replace the X module (Fig 3b). Its handshake lines ensure that the generator will be able to satisfy all dynamic operating conditions in this particular situation.

After you ascertain that module Y apparently functions properly, it goes into limited production; by this time, however, the development of module X is complete. A problem arises, though, because only one prototype of Module X is available, and a number of development teams need to use it to carry out tests on the complete dual-module system.

The simple solution is to use a number of word generators in place of the lone prototype X module. Because the X module's performance had been an unknown factor, the initial word-generator testing sequence on module Y relied on estimated data. Now, after analyzing the X module's actual performance, you can set up the word generator to run a much more realistic dual-module system test.

Worst-case testing is no problem

Next, you decide to do a worst-case test sequence, which is good design practice. To do so, you have to extend the output signals of module X to their limits—an easy task for the word generator. After you install the X and Y modules at a customer site, problems arise during worst-case testing. For practical reasons, it's not possible to carry out tests on site, but because the

word generator has the ability to generate predetermined data patterns, you can easily simulate a circuit's environmental conditions. In fact, even when the size of the system makes recreating environmental conditions in the development lab impossible, you can use a word generator to analyze the system under realistic conditions as if you were actually on site.

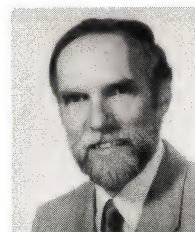
A final obstacle presents itself when crosstalk and oscillation problems arise in module X, necessitating the use of an oscilloscope. Using a logic analyzer is impossible in this situation because an analyzer recognizes the error condition too late to trigger the oscilloscope.

You need only one of the word generator's channels to produce a trigger signal for the oscilloscope (Fig 3c). You can place this trigger signal anywhere in the data stream—even in front of the bit stream that causes the error—and thereby allow the oscilloscope to trace the complete history of the error. If you program the word generator to repeat the output sequence automatically, you don't even have to use a storage oscilloscope to measure the output pattern.

EDN

Authors' biographies

Robert Delp is an applications manager at Dolch Logic Instruments Inc (San Jose, CA). In this position, he provides technical-sales and customer support for the US, Canada, and Japan. He has been with the company for four years. Bob holds a bachelor's degree in Industrial Technology from San Francisco State University and a master's degree in the same discipline from San Jose State University. In his free time, he enjoys backpacking, camping, and cross-country skiing.



Peter Kleindienst is an international applications manager for Dolch Logic Instruments GmbH (Dietzenbach, West Germany). His responsibilities include technical and sales support for Europe and the Middle and Far East. In his off hours, Peter simply strives to have fun.

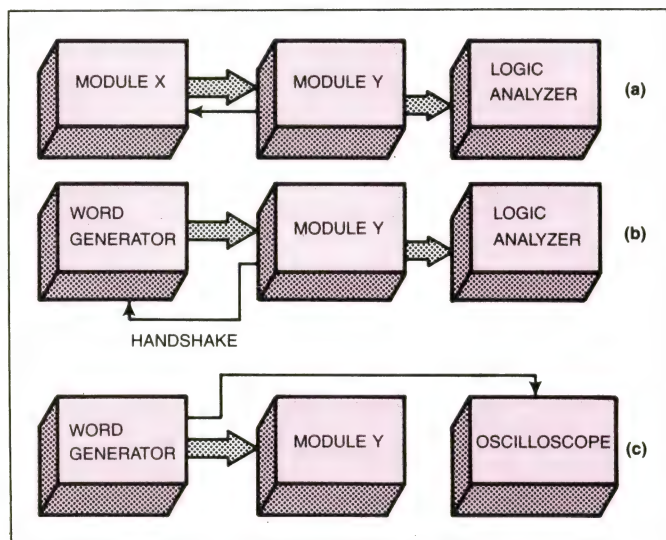


Fig 3—Word generators are particularly useful when you have to test a system comprising two independently developed modules (a). The generator allows you to test module Y (b) before the design of module X is complete. For worst-case testing (c), you can even use the generator to trigger an oscilloscope.

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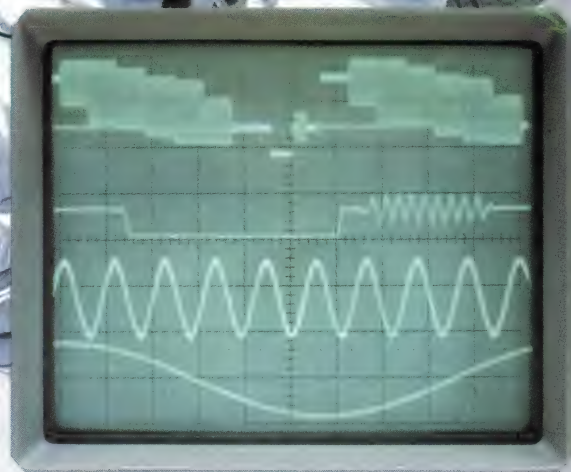
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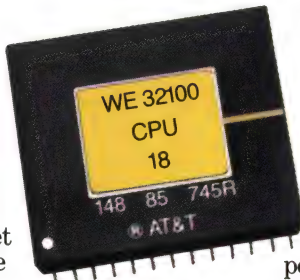
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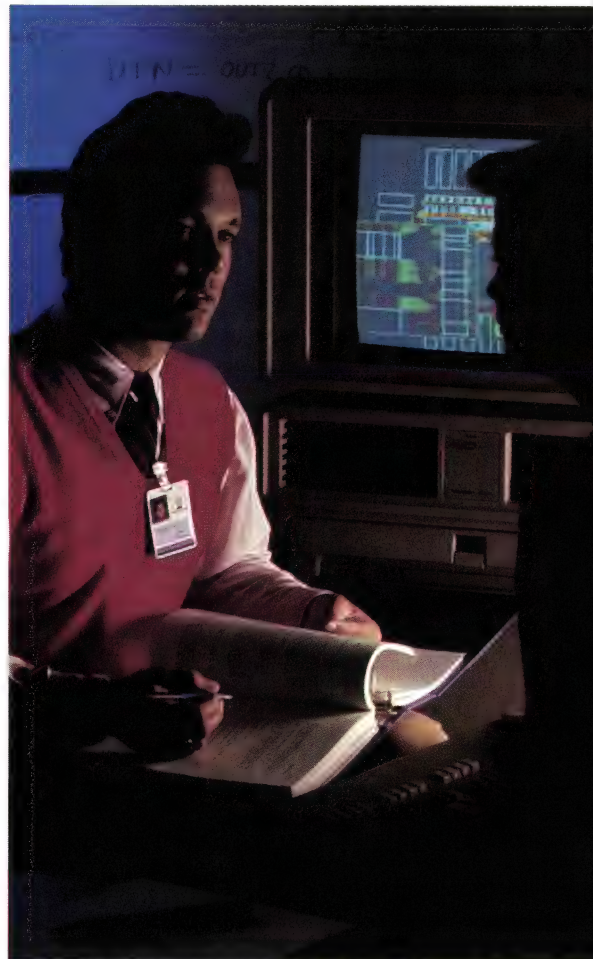
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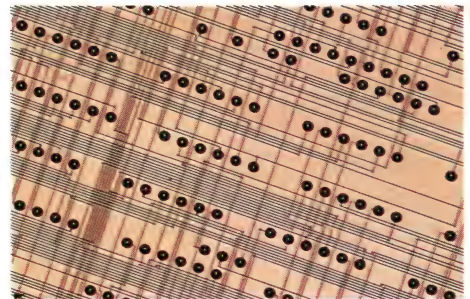
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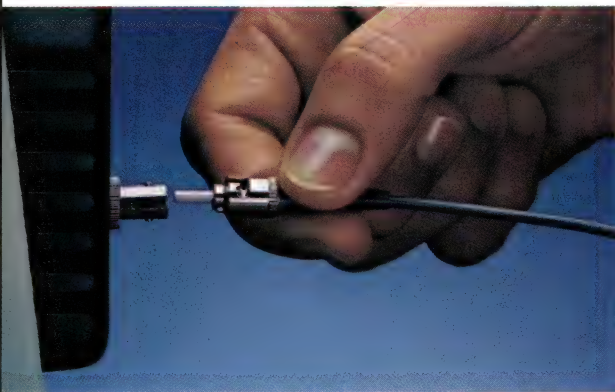
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Test hardware helps pinpoint software bugs

Setting breakpoints through the use of software debugging tools can solve some of your problems, but other bugs are more difficult to isolate and fix. Your chances of doing so improve considerably when you add an in-circuit emulator and a bus-state analyzer to your debugging arsenal.

Thomas R Blakeslee and John S James,
Orion Instruments

Hardware-assisted software debugging of programs can help you track down quickly the hard-to-find or subtle bugs that might otherwise delay a project for weeks or even months. Typical examples include interrupt-related and other timing-critical bugs that you can't reproduce; errors that appear only while the system is running at full speed; and system crashes that occur very infrequently (often only once in days or months) and that wipe out all evidence of what went wrong.

Using traditional, software-only debugging techniques, you may spend weeks looking for the bug, and even then you may never find it at all. Inspection of the source-code listings may not tell you anything useful, and trying to check progress of the program is a slow

business because you have to set breakpoints by trial-and-error methods. Besides, breakpoints have a number of limitations.

First, if the program never reaches a breakpoint, but instead ends up in a loop or crashes, there may be no indication of how the program reached the point at which it looped or crashed, and what operations caused that event. Second, you can only trap instruction execution points; you have no way of trapping other bug symptoms, such as the writing of garbage to the memory. Third, breakpoints don't give you any record of the machine activity leading up to the breakpoint (or the crash). Finally, breakpoints stop all processing, so the information they give you is inadequate to identify bugs related to real-time interactions.

Hardware extends breakpoint capability

This is not to say that breakpoints are useless; on the contrary, they are quite adequate for finding some types of bugs. When breakpoints are appropriate, you can make them more effective by using an in-circuit emulator, which provides all of the basic breakpoint functions of a software debugger (stopping at a breakpoint, single-stepping, and displaying and changing registers and memory).

The emulator has several advantages over the software debugger. First, the emulator can work with ROM-resident programs. Second, it retains control at all times. Consequently, it can prevent the program under test from overwriting or destroying either the

Using traditional, software-only debugging techniques, you may spend weeks looking for a bug, and even then you may never find it at all.

LISTING 1

cy#	CONT	ADR	DATA	
-5	B7	00A6	20FA	JR NZ, START-LOOP
-3	B7	00A8	C9	RET
-2	F7	17FE	FF read	
-1	F7	17FF	FF read	
0	B7	FFFF	1831	JR 32

debugger or the operating system. Also, you can stop the program under test at any time to examine registers and memory—a facility that very few debuggers can provide.

When the bug is so complex or subtle that you have no idea where to set breakpoints, a hardware bus-state analyzer can be even more helpful. The analyzer continuously records bus cycles while the program runs at full speed. It saves all bus information, up to the limit of the available trace-buffer memory, which is usually hundreds of cycles.

Bus-state analyzer tests all cycle types

Meanwhile, the analyzer tests all cycles, looking for any requested combinations or sequences of values. For example, if the program is writing bad data into an array or any other part of memory, you could have the analyzer test for a write operation that specifies a range or set of data values written into a range of addresses that correspond to the array. When the conditions you specified occur, the analyzer will trigger and stop collecting new bus cycles. Then you can examine the trace, using such tools as a symbolic disassembler, to see not only what instructions wrote the bad data, but also what happened before the instructions were executed.

The trigger specification can involve more than a single cycle. For example, you could specify two or more independent tests that must occur on sequential bus cycles. More commonly, a delay count delays the trigger for a given number of cycles after the other conditions are met; this count allows you to see what happens after the triggering event, as well as before it. Other analyzer capabilities include filtering (selecting only certain cycles) and counting the exact number of cycles between two points of a program.

Analyzers watch the program run at full speed, with complete transparency. What's more, the methodology of triggering on the symptom of the bug avoids the

guesswork of where to place breakpoints, which must in any case stop the program in order to be useful. An integrated analyzer-emulator can provide the best of both worlds: It can trigger in response to the symptoms of a problem and use a nonmaskable interrupt (NMI) to simulate a breakpoint at that time. Also, integrated analyzer-emulators provide most or all of the following features:

- The analyzer can cause a scope or other external equipment to trigger as a result of any of the logical tests mentioned previously.
- You can progressively append new tests to the trigger specification, and you can display the cumulative specification at any time.
- You can save the current state of the work as a disk file, and later continue from where the session left off. The file can include macros specifying sequential software tests for automated testing of hardware.
- An analyzer can run unattended for weeks if necessary, perhaps at a customer's site. When a problem arises, the analyzer will save the trace for local examination, or for transmission by telephone.
- An analyzer with automatic reset can restart the system after a crash. Adding new tests to the trigger specification or inspecting a different area of the trace after each crash will add new data to help you identify the problem.

See the analyzer in action

Two examples show how to use an integrated analyzer-emulator to find the cause of a crash and how to check that a loop is operating correctly. The first example is the debugging of a Z80 program that has a tendency to work properly for about a minute and then crash. The program code occupies locations 0 through 1000_{HEX}; RAM occupies locations 1800_{HEX} through 1FFF_{HEX}.

LISTING 2

5 SR resetting

cy#	CONT	ADR	DATA	
-5	B7	00A6	20FA	JR NZ, START-LOOP
-3	B7	00A8	C9	RET
-2	F7	17FE	FF read	
-1	F7	17FF	FF read	
0	B7	FFFF	1831	JR 32
resetting				
cy#	CONT	ADR	DATA	
-5	B7	00A6	20FA	JR NZ, START-LOOP
-3	B7	00A8	C9	RET
-2	F7	17FE	FF read	
-1	F7	17FF	FF read	
0	B7	FFFF	1831	JR 32
resetting				
cy#	CONT	ADR	DATA	
-5	B7	00A6	20FA	JR NZ, START-LOOP
-3	B7	00A8	C9	RET
-2	F7	17FE	FF read	
-1	F7	17FF	FF read	
0	B7	FFFF	1831	JR 32

The first step is to set up the analyzer to look for instruction-fetch cycles at addresses outside the code area. When the program crashes, the screen displays the instruction trace (ie, the contents of the trace buffer) shown in **Listing 1**. Sure enough, the program is attempting to execute an instruction at FFFF_{HEX}; the RET instruction is trying to read the stack at 17FF_{HEX}, where there is no RAM. The stack pointer was initialized to 18FF_{HEX}, so it appears the bug is a stack overflow.

The second step is to use the analyzer's start-and-repeat feature to see whether the error is always the same. The command 5 SR starts the analyzer and target program, displays five lines of the triggered display, then resets the target system and restarts both the target program and the analyzer. This sequence continues indefinitely until you stop it by pressing a key. In the case of an intermittent crash, you could send the screen output to a printer or to a disk file, in order to gather, over a period of hours or days, data on all conditions leading up to a crash. The resulting trace (**Listing 2**) confirms that the crash does occur in the same way every time.

LISTING 3

cy#	CONT	ADR	DATA	
F01	B7	00A8	C9	RET
F02	F7	18FA	90 read	
F03	B7	00A8	C9	RET
F04	F7	18F8	90 read	
F05	B7	00A8	C9	RET
F06	F7	18F6	90 read	
F07	B7	00A8	C9	RET
F08	F7	18F4	90 read	
F09	B7	00A8	C9	RET
F0A	F7	18F2	90 read	
F0B	B7	00A8	C9	RET
F0C	F7	18F0	90 read	
F0D	B7	00A8	C9	RET
F0E	F7	18EE	90 read	
F0F	B7	00A8	C9	RET
F10	F7	18EC	90 read	

In the case of an intermittent crash, you can send the screen output to a printer or a disk file in order to gather data on conditions leading up to a crash.

The third step is to use the analyzer's filter feature to obtain a better understanding of the stack-overflow problem. Filtering means that the analyzer examines the inputs in real time and keeps only certain bus cycles in the trace buffer. You could also include the cycles after each of the selected ones. In this case, you'd use these features to look at the RET instruction at address A8_{HEX} and the stack address accessed by that instruction. The trace (Listing 3) shows that each time the program reaches address A8_{HEX}, the stack pointer address decreases, indicating that at some point the program is pushing a 16-bit value onto the stack but

never popping it off again. You know this event is occurring sometime after the program reaches address A8_{HEX}, so you can ask for a trace that triggers on that address and shows three cycles before the trigger and 10 cycles after it.

The resulting trace (Listing 4) shows that there's a Push command at address 8B_{HEX} that could be the cause of the problem; reference to the program listing shows that, in fact, the Push instruction doesn't belong there. You can test this idea immediately by storing a zero (a no-op instruction) to memory location 8B_{HEX} with a simple monitor command. After making that change,

LISTING 4

cy#	CONT	ADR	DATA	
-5	B7	00A3	20FD	JR NZ, START-LOOP
-3	B7	00A5	25	DEC H
-2	B7	00A6	20FA	JR NZ, START-LOOP
0	B7	00A8	C9	RET
1	F7	18FA	8F read	
2	F7	18FB	00 read	
3	B7	008F	C38800	JP SEND-OUT
6	B7 SEND-OUT	0088	D379	OUT (LEDS), A
8	5F	8079	80 out	
9	B7	008A	0F	RRCA
A	B7	008B	D5	PUSH DE
B	D7	18FB	40 write	
C	D7	18FA	20 write	
D	B7	008C	CDA000	CALL DELAY-SUB

LISTING 5

cy#	CONT	ADR	DATA	
-5	B7	00A3	20FD	JR NZ, START-LOOP
-3	B7	00A5	25	DEC H
-2	B7	00A6	20FA	JR NZ, START-LOOP
0	B7	00A8	C9	RET
1	F7	18FC	8F read	
2	F7	18FD	00 read	
3	B7	008F	C38800	JP SEND-OUT
6	B7 SEND-OUT	0088	D379	OUT (LEDS), A
8	5F	8079	80 out	
9	B7	008A	0F	RRCA
A	B7	008B	00	NOP
B	B7	008C	CDA000	CALL DELAY-SUB

the program seems to run correctly (**Listing 5**), indicating that the intrusive Push instruction was in fact the reason for the crash.

You now have a small hierarchy of choices: You can immediately burn an EPROM that contains the modified program or save the patched program to a disk file directly from the emulator memory, or you can enter the DOS command to return to PC-DOS so that you can edit and reassemble the program.

If you prefer to fix several bugs before correcting the source code, you can invoke a logging feature that will automatically send just your patches (not the rest of the screen output) to the printer. You can safely continue the session after making each patch and then later correct the source code from the fixes recorded in the printed log.

A second example shows how you use the cycle-counting feature of an analyzer-emulator to check a

LISTING 6

DELAY-SUB	00A0	21FF40	LD HL,40FF
START-LOOP	00A3	2D	DEC L
	00A4	20FD	JR NZ,START-LOOP
	00A6	25	DEC H
	00A7	20FA	JR NZ,START-LOOP
	00A9	C9	RET

LISTING 7

AF=8051 (sZ-A-pnC) BC= 0 DE= 20 HL=FFFF IX=1234 IY=5678 SP=18FC PC=A0
 DELAY-SUB 00A0 21FF40 LD HL,40FF (next step)

(a)

NMI
 AF=8051 (sZ-A-pnC) BC= 0 DE= 20 HL=40FF IX=1234 IY=5678 SP=18FC PC=A3
 START-LOOP 00A3 2D DEC L (next step)

NMI
 AF=80AB (Sz-a-pnC) BC= 0 DE= 20 HL=40FE IX=1234 IY=5678 SP=18FC PC=A4
 00A4 20FD JR NZ,START-LOOP (next step)

NMI
 AF=80AB (Sz-a-pnC) BC= 0 DE= 20 HL=40FE IX=1234 IY=5678 SP=18FC PC=A3
 START-LOOP 00A3 2D DEC L (next step)

NMI
 AF=80AB (Sz-a-pnC) BC= 0 DE= 20 HL=40FD IX=1234 IY=5678 SP=18FC PC=A4
 00A4 20FD JR NZ,START-LOOP (next step)

NMI
 AF=80AB (Sz-a-pnC) BC= 0 DE= 20 HL=40FD IX=1234 IY=5678 SP=18FC PC=A3
 START-LOOP 00A3 2D DEC L (next step)

NMI
 AF=80AB (Sz-a-pnC) BC= 0 DE= 20 HL=40FC IX=1234 IY=5678 SP=18FC PC=A4
 00A4 20FD JR NZ,START-LOOP (next step)

(b)

You can safely continue a session after making each patch and then later correct the source code from the fixes recorded in the printed log.

delay routine very quickly. **Listing 6** shows the listing of a typical routine consisting of an inner loop that runs FF_{HEX} times, and an outer loop that runs 40_{HEX} times. This listing was disassembled directly from RAM memory in the emulator, because when you're testing a program, the emulator must keep full control of execution. The emulator can't exercise that control if the program resides in ROM, so the emulator always copies

the program from ROM into its own RAM for test execution.

If you're using only software debugging methods, you'll have to single-step through the loop, examining the registers at each step to ensure that the correct number of iterations are executed. To single-step through the loop, you must first have the software debugger obtain "breakpoint control" by executing a

LISTING 8

cy#	CONT	ADR	DATA	
-4	B7	START-LOOP	00A3 2D	DEC L
-3	B7		00A4 20FD	JR NZ, START-LOOP
-1	B7	START-LOOP	00A3 2D	DEC L
0	B7		00A4 20FD	JR NZ, START-LOOP
2	B7		00A6 25	DEC H
3	B7		00A7 20FA	JR NZ, START-LOOP
5	B7	START-LOOP	00A3 2D	DEC L
6	B7		00A4 20FD	JR NZ, START-LOOP
8	B7	START-LOOP	00A3 2D	DEC L
9	B7		00A4 20FD	JR NZ, START-LOOP

LISTING 9

cy#	CONT	ADR	DATA	
-5	F7		00A5 FD read	
-4	B7	START-LOOP	00A3 2D	DEC L
-3	B7		00A4 20FD	JR NZ, START-LOOP
-1	B7		00A6 25	DEC H
0	B7		00A7 20FA	JR NZ, START-LOOP
2	B7		00A9 C9	RET
3	F7		18FC 90 read	
4	F7		18FD 00 read	
5	B7		0090 C38800	JP 88
8	B7		0088 D379	OUT (LEDS), A
A	5F		8079 80 out	
B	B7		008A 0F	RRCA
C	B7		008B 14	INC D
D	B7		008C 00	NOP
E	B7		008D CDA000	CALL DELAY-SUB
11	D7		18FD 00 write	
12	D7		18FC 90 write	
13	B7	DELAY-SUB	00A0 21FF40	LD HL, 40FF
16	B7	START-LOOP	00A3 2D	DEC L

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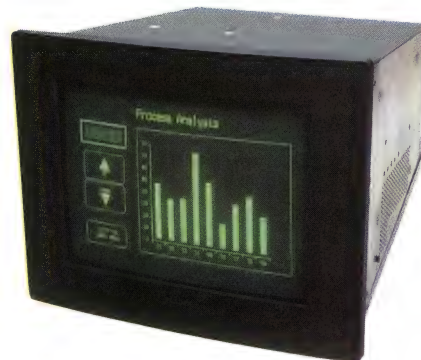
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A quick and elegant way to make sure that a loop works properly is to use an analyzer command to count the number of cycles between two points in the program.

breakpoint at address A0_{HEX}; you'll see the display shown in **Listing 7a**. As you can see from the contents of the program counter (PC), the instruction at address A0_{HEX} has not yet been executed.

Once you've established debug control, you can step through the program by pressing a function key that generates an NMI, thereby allowing the program to execute just one instruction. You can continue stepping through the program in this manner for as long as you like (**Listing 7b**), but you will soon find that going through tens of thousands of steps quickly gets boring.

Analyzer counts program cycles

A much quicker and more elegant way to make sure that the loop works properly is to use an analyzer command to count the number of cycles between two points in the program. If, for example, you enter the command "A0 A6 CYCLES?", the response will be "=300", indicating that 300_{HEX} cycles were executed between addresses A0_{HEX} and A6_{HEX}. The LD HL instruction takes three cycles, and the two instructions that compose the inner loop take a total of three cycles. The total for the inner loop should be $3 + (3 \times \text{FF}_{\text{HEX}}) = 300_{\text{HEX}}$; the display thus indicates that the inner loop works as desired.

To check the operation of the entire delay subroutine, just enter "A0 A9 CYCLES?"; the response is "=C0C0", which is $40 \times 303_{\text{HEX}}$. This response confirms that the outer loop (which includes the inner loop plus three cycles) was executed 40 times. This cycle-counting technique is excellent for making gross checks on a new program to see what parts of it are or are not functioning as intended.

To examine loop operation more closely, you can set the analyzer trigger to show only the interesting parts of the trace. For example, to look at the end of an inner loop, you can set the trigger to wait until address A3, the decrement instruction in the inner loop, has occurred FF_{HEX} times. **Listing 8** shows the resulting trace. The trigger cycle (cy#0) is the next instruction after the FF_{HEX} pass round the inner loop. You'll see that on completion of this pass, the outer loop correctly decrements the H register (cy#2), after which the inner loop resumes. Similarly, you could trace the exit from the subroutine by triggering on the fortieth iteration of the outer loop. The resulting trace (**Listing 9**) shows the correct completion of the fortieth iteration and the return to the section of code that called the delay subroutine.

In general, if you find yourself spending long hours

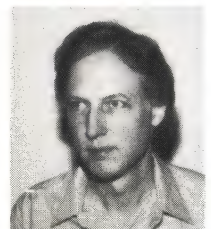
single-stepping through programs, or pouring over program listings looking for errors, you are probably wasting a lot of time. The ideal debugging technique is to use analyzer triggers or breakpoints or both, as appropriate. A development system that includes an integrated analyzer-emulator renders both techniques available to you at all times. **EDN**

Authors' biographies

Thomas R. Blakeslee is the founder of Orion Instruments (Redwood City, CA) and an expert on digital systems design. His textbook Digital Design with Standard MSI and LSI (Wiley Interscience) has been adopted as a text by more than 75 colleges and universities. He is also author of The Right Brain, published by Doubleday. He is a 1962 Caltech graduate and was a founder and engineering vice president of Logisticon Inc in Sunnyvale, CA. He enjoys music, skiing, tennis, and windsurfing.



John S. James is an independent consultant who has worked with Orion Instruments on various projects. He is a specialist in the Forth programming language and has written technical and tutorial articles on its use. He is also a partner in the CommuniTree Group, for which he co-designed a computer-conferencing bulletin board. Other interests include technical writing in the area of medical research.



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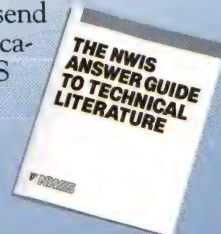
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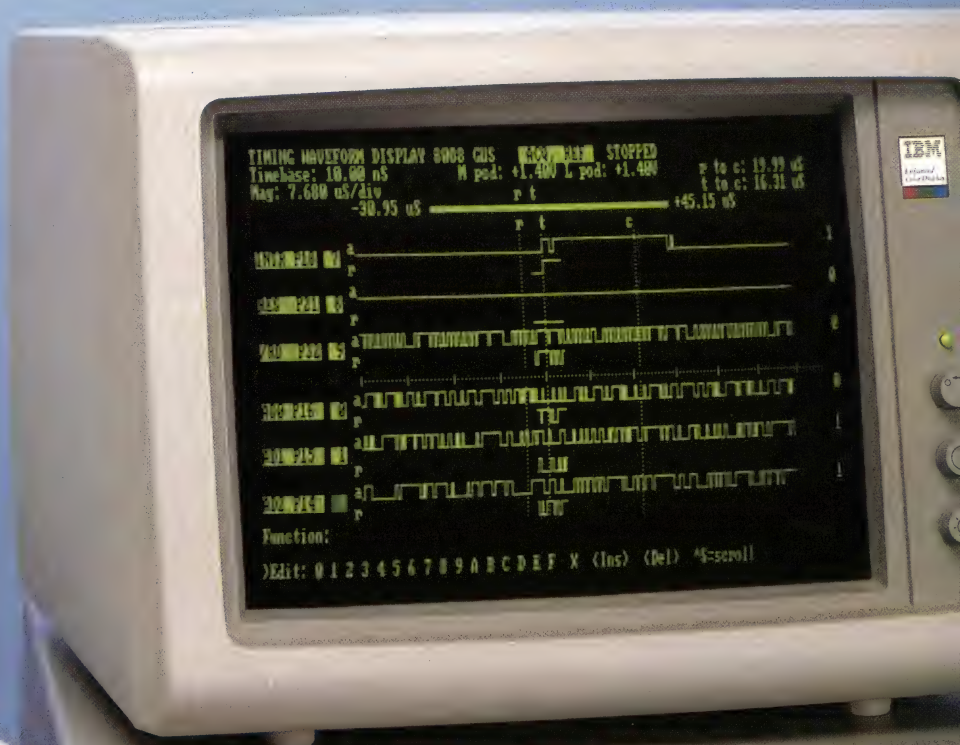


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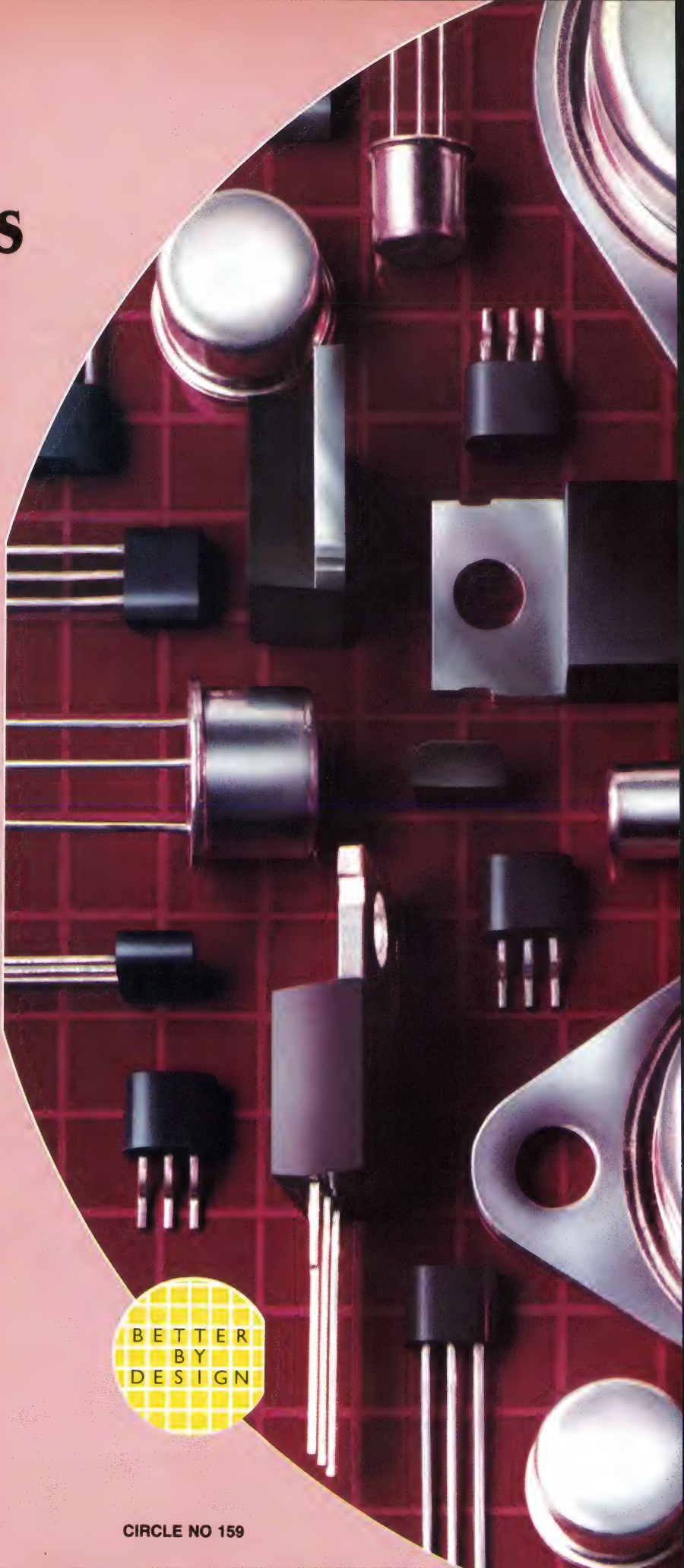
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Fault simulation rates effectiveness of test patterns

You can use several fault-simulation techniques to evaluate how effectively a set of test vectors will uncover manufacturing defects in your circuit designs. Fault-simulation programs can help you produce the exact set of test vectors you need for a given level of fault coverage.

Geoffrey Indrajo and Laung-Terng Wang,
Daisy Systems Corp

Fault simulation can help you rate the effectiveness of test patterns in finding manufacturing defects in your design. A fault simulator is a program that computes the percentage of manufacturing defects, or faults, that a given set of test vectors will detect. A fault simulator runs many logic simulations, and you can use several simulation techniques to minimize the time required for fault simulation. The results of the simulation programs provide you with hard data about both the effectiveness of test vectors and the location of untested nodes in your design.

A fault simulator contains models of the types of faults found in designs once they've been manufactured. The most common faults are stuck-at-0 (S-A-0) and stuck-at-1 (S-A-1) faults. The first type of fault, S-A-0, maintains a logical low at the node to which the simulator attaches the fault, emulating a tied-to-ground

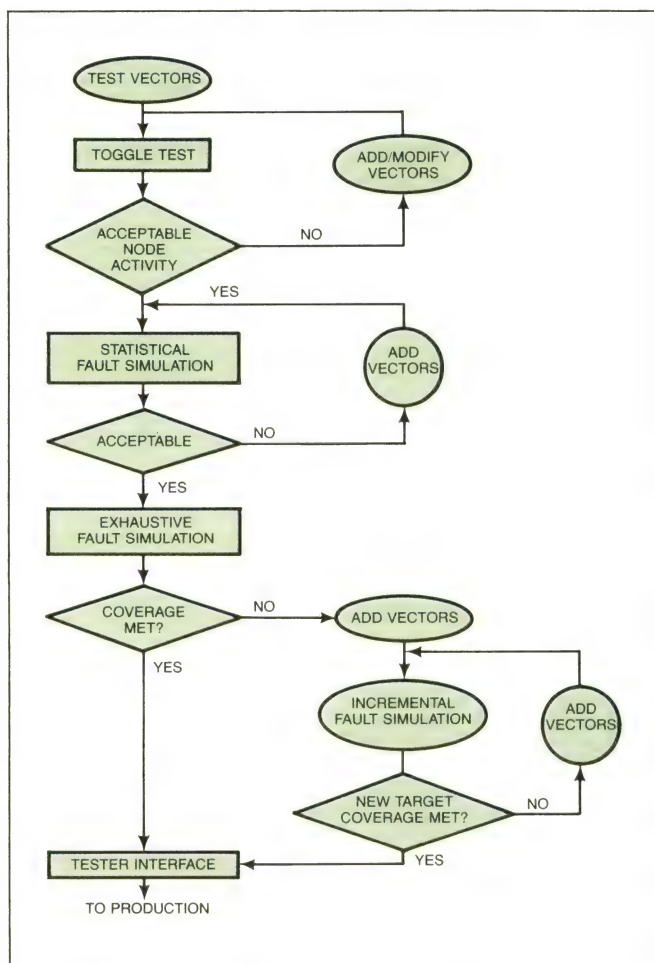


Fig 1—Several levels of simulation allow you to determine the set of test vectors that will provide the level of fault coverage you need.

The results of fault simulation give you hard data about the effectiveness of test vectors and the location of untested nodes in your design.

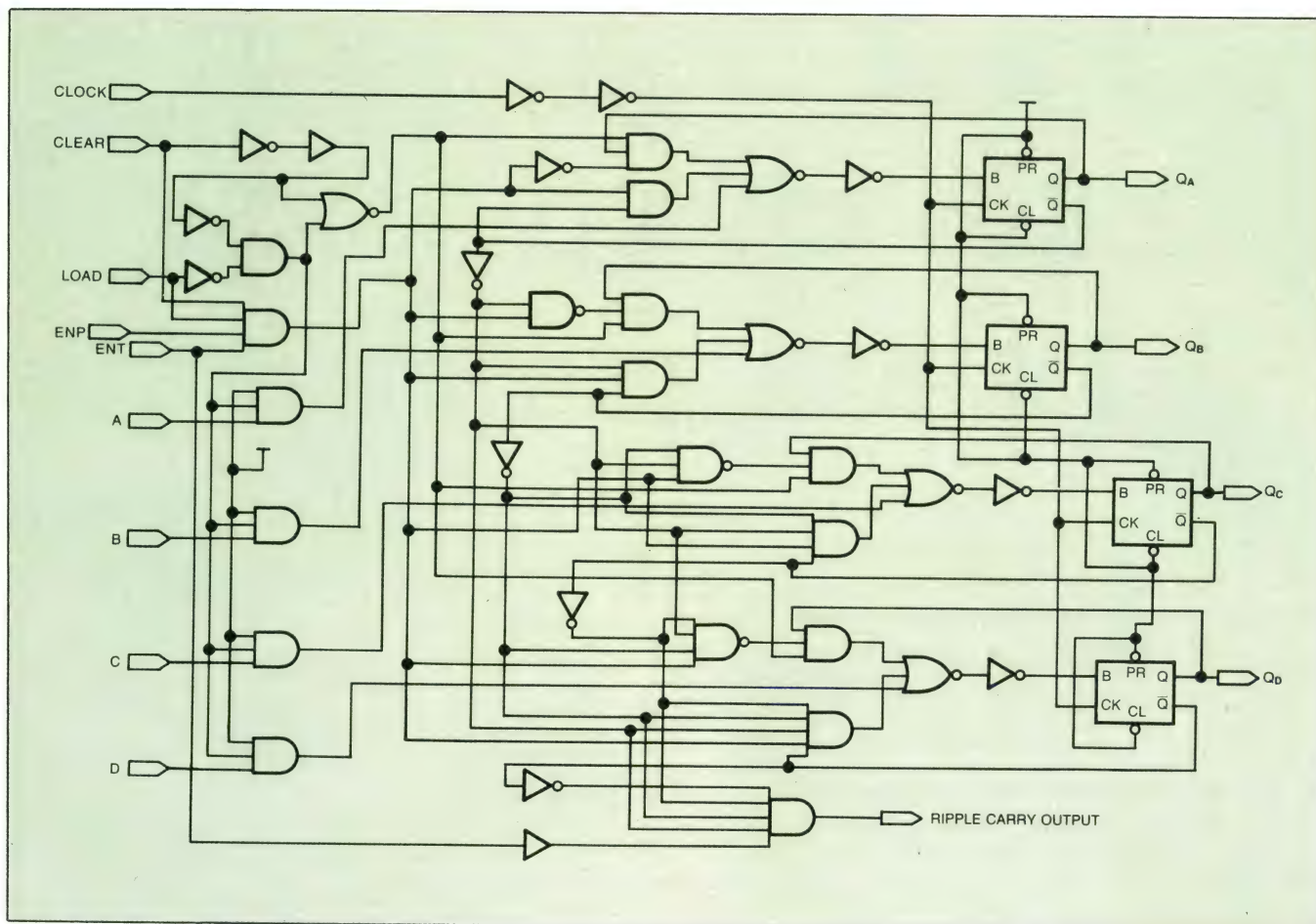


Fig 2—This four-bit counter is identical in design to the 74LS163 IC. Convergent fault simulation of this circuit with the test-vector set in **Fig 3** results in the toggle-test report in **Fig 4**.

defect for the node. The other fault, S-A-1, maintains a logical high at the node to which the simulator attaches it, emulating a tied-to- V_{CC} defect for the node. These two faults accurately represent the overwhelming majority of manufacturing defects, so most fault simulators incorporate at least these models.

Simulator inserts faults

When a simulator performs fault simulation, it assigns a fault to a node in your design and then runs a logic simulation. Using your test vectors as input, the fault simulator computes the output of the design with the fault. The simulator then compares the results from the design with the fault with the results from a design without any manufacturing defects. If the two sets of results differ, the test vectors have detected a fault. If the results differ by an unknown output state, then the test vectors have potentially detected the fault.

When the simulator observes no difference in the logic state of the outputs of both designs, you know that the test vectors have left the fault undetected. An undetected fault results from redundant circuitry, lack of the right input stimuli to exercise a node, or the inability to observe the effect of the input stimulus. If your fault simulation leaves too many faults undetected, you can use the output of the fault simulation and your logic diagram to decide what test vectors to add to your test-vector set.

The percentage of faults detected by a given set of test vectors is called the fault coverage for those vectors. The fault simulator divides the number of detected faults by the number of discrete (nonequivalent) faults possible in the design. A low fault-coverage figure indicates that the test-vector set is inadequate for detecting manufacturing defects during testing; 100% fault coverage indicates that the set can detect all

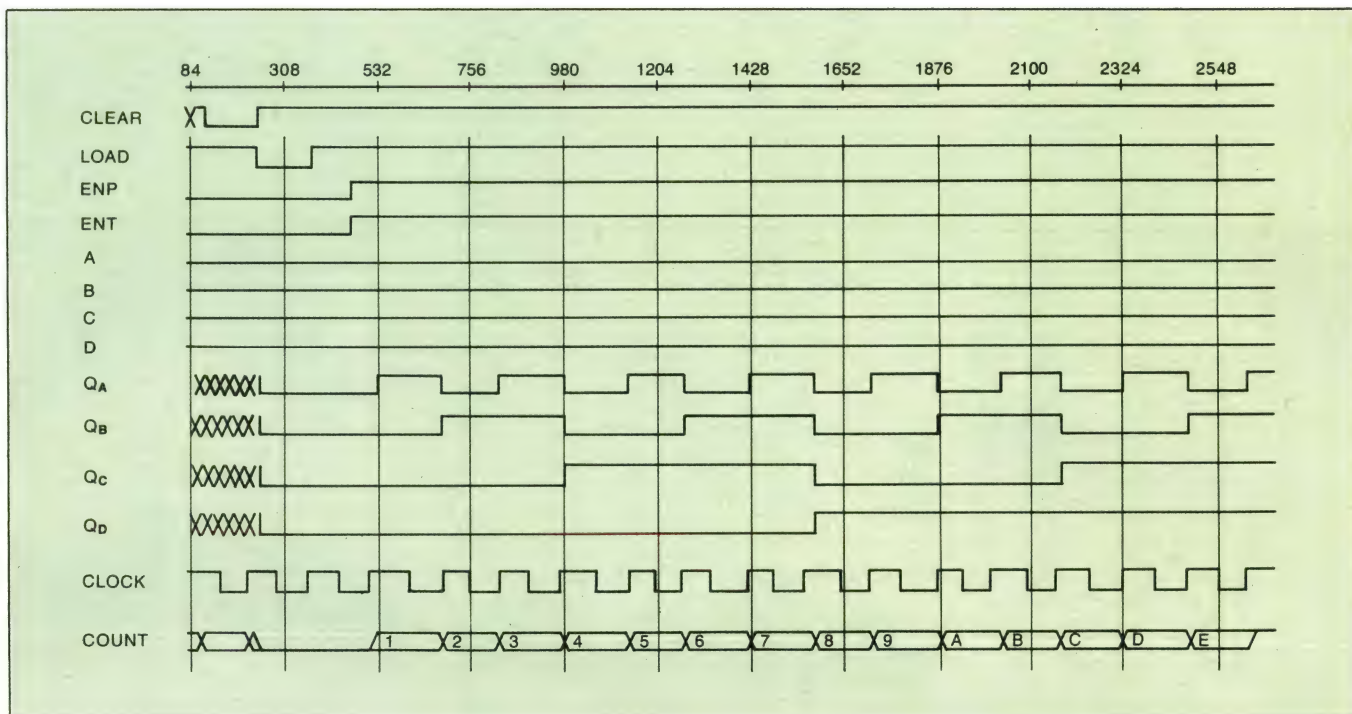


Fig 3—Fault simulation evaluates test vectors for their effectiveness in finding manufacturing faults. This set of vectors exercises the circuit in Fig 2.

of the manufacturing faults modeled by the fault simulator. Only small or very structured designs can attain 100% fault coverage; this figure virtually ensures that a design will function correctly if it passes the set of test vectors.

The fault simulator tabulates the results of the fault simulation and produces a report called a fault dictionary (Ref 1). The fault dictionary lists the time, location, and state of all faults detected or potentially detected. You use the fault dictionary to identify the nodes that require additional test patterns and the portions of your circuit that may contain design flaws.

Convergent simulation saves time

Because a fault simulator runs a logic simulation for each fault it puts in your circuit, fault simulation can potentially take an unacceptably long time to complete. To minimize the time you need to develop a set of test vectors that provides acceptable fault coverage, you can use a convergent fault simulator. Besides running an exhaustive fault simulation, such a simulator runs a series of other programs that let you rapidly determine the exact set of vectors you need (Fig 1). Without a convergent fault simulator, you'd have to run a complete fault simulation each time you added or changed

vectors, because you could never be sure what effect the additions or changes would have. In addition, subsequent fault simulations would rerun vectors that you already know provide a certain level of coverage.

Of all the programs in a convergent fault simulation, the first—the toggle test—takes the least amount of time and provides the roughest estimate of fault coverage. The toggle test doesn't actually insert faults into your design; instead, it performs a logic simulation and determines how many nodes in your design have been exercised by the test vectors. An exercised node is one that makes a transition from a logical 0 to a logical 1 or unknown state, or a transition from a logical 1 to a logical 0 or unknown state, at least once during the logic simulation.

Because a set of vectors must toggle a node in order to find a fault at that node, all unexercised nodes in the toggle test contain undetected faults. The toggle test, therefore, separates those faults that can be detected from those that can't be detected. If the percentage of nodes that can be detected is lower than your targeted fault coverage, you already know, without running a fault simulation, that you need more test vectors. If the percentage is higher than the fault coverage, you can proceed with fault simulation. You can shorten the

The fault simulator assigns faults to the nodes in your design and then runs a logic simulation for each fault.

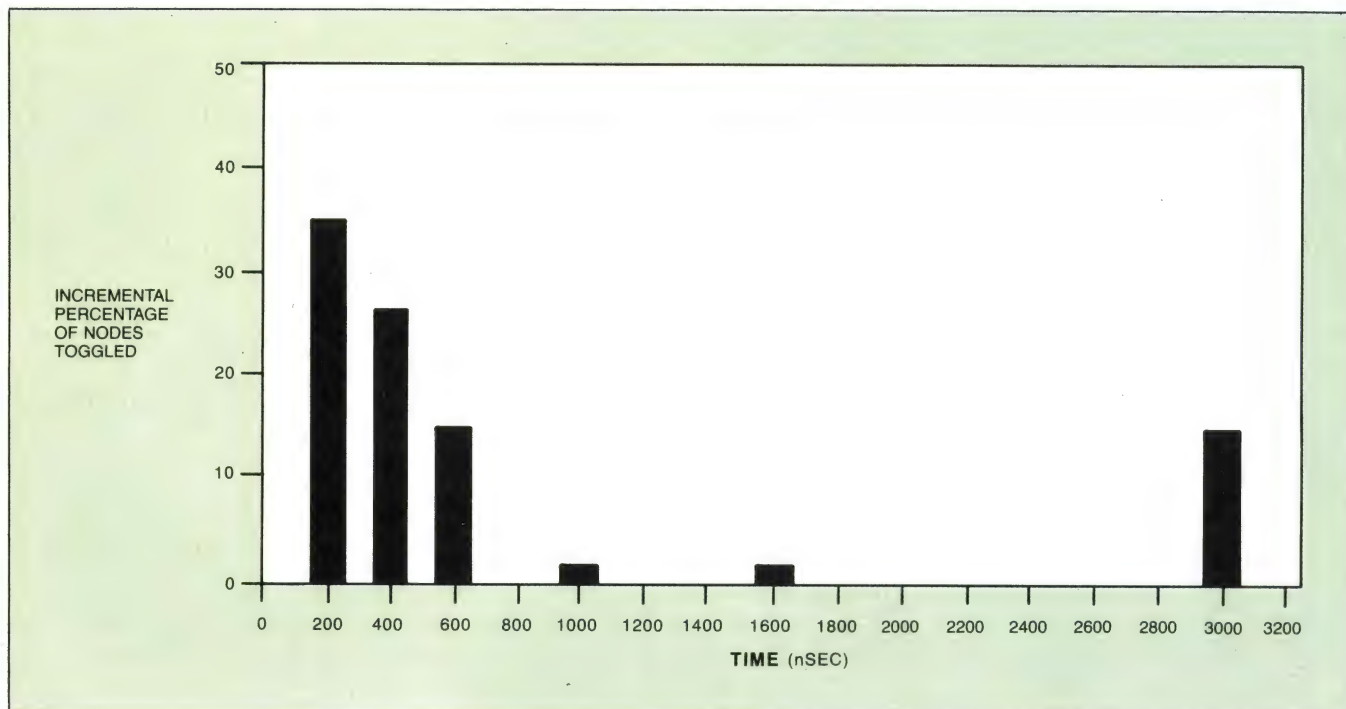


Fig 4—Histogram reports, such as this toggle-test report for the circuit in **Fig 2**, show inactive periods during which the test vectors toggle no nodes that they haven't toggled already. The test vectors in these inactive periods may be unnecessary for production testing of the device, so you may be able to remove them from the test-vector set.

simulation by directing the toggle-testing program to prevent the fault simulator from inserting faults at untoggled nodes.

The output of the toggle test also helps you eliminate test vectors that don't identify faults. The toggle test generates a report of the percentage of nodes toggled by groups of vectors within your vector set. For example, the circuit in **Fig 2**, when exercised by the test pattern in **Fig 3**, results in the toggle-test report in **Fig 4**. Test vectors in the time period between $t=1600$ nsec and $t=3000$ nsec toggle an insignificant number of nodes. Although these test patterns may be useful for testing the function of the device, they may not be necessary for achieving a given fault coverage. By removing these vectors, you can obtain a much shorter test without sacrificing fault coverage.

Once you've used toggle testing to eliminate unnecessary test vectors and untoggled nodes, you can use the next program, the statistical fault simulator, to gain a more accurate measure of the fault coverage. The statistical fault simulator selects a random sample of nodes in your design and performs a fault simulation on them. Because the sample is much smaller than the entire design, a statistical fault simulation runs more

quickly than an exhaustive fault simulation. Statistical theory confirms that the results of the statistical fault simulation are accurate within user-specified levels of confidence and precision (**Ref 2**).

If your design is so large that exhaustive fault simulation is unwieldy, you might accept the output of statistical fault analysis as a sufficient indication of the fault coverage of your test vectors. Statistical fault simulation, like toggle testing, provides an output report that you can use to evaluate your vector set.

If you don't choose to accept the output of the statistical fault simulator as sufficient, however, you can perform an exhaustive simulation. Because the first two tests have given you some indication of whether your test vectors will provide adequate fault coverage, you'll be able to run fewer exhaustive fault simulations. Because the exhaustive fault simulation checks every modeled fault at every node, you get an accurate report of the fault coverage that your test-vector set will provide for your design.

If you find that your test-vector set doesn't provide enough fault coverage, you need to add more vectors to detect faults at the nodes that your vector set missed. After adding these vectors, you run an incremental

fault simulation. Incremental fault simulation looks only for the faults left undetected by the original vector set, so it runs much faster than exhaustive simulation does.

Fault dictionary compiles results

To evaluate the coverage provided by your test vectors, you use the reports resulting from each of the fault simulations you've performed. These reports, which comprise the fault dictionary, provide a list of the injected faults and the results of the simulations. A lucid and informative fault dictionary can be as important to your test development as simulation speed and accuracy.

The first report in a fault dictionary lists the faults that the fault simulator injects into your design. This fault list specifies the type of fault injected—for example, input S-A-1, input S-A-0, output S-A-1, output S-A-0—and where the fault is injected. Fig 5 shows

FAULT LIST

FAULT NUMBER	TYPE	LOCATION
26	OS0	@74LS163 1:XSIG22
27	OS1	@74LS163 1:XSIG22
28	OS0	@74LS163 1:XSIG64
29	OS1	@74LS163 1:XSIG64
30	IS1	@74LS163 1:XSIG64 (AT) @74LS163 1:XSIG15
31	IS1	@74LS163 1:XSIG64 (AT) @74LS163 1:XSIG16
32	IS1	@74LS163 1:XSIG9 (AT) @74LS163 1:XSIG12
33	IS1	@74LS163 1:XSIG9 (AT) @74LS163 1:XSIG13
34	IS1	@74LS163 1:XSIG28 (AT) @74LS163 1:XSIG32
35	IS1	@74LS163 1:XSIG28 (AT) @74LS163 1:XSIG12
36	OS0	@74LS163 1:XSIG4
37	OS1	@74LS163 1:XSIG4
38	IS0	@74LS163 1:XSIG4 (AT) @74LS163 1:XSIG22
39	IS0	@74LS163 1:XSIG4 (AT) @74LS163 1:XSIG64
40	IS1	@74LS163 1:XSIG50 (AT) @74LS163 1:O1
41	IS1	@74LS163 1:XSIG50 (AT) @74LS163 1:XSIG46
42	IS1	@74LS163 1:XSIG50 (AT) @74LS163 1:XSIG4
43	IS1	@74LS163 1:XSIG24 (AT) @74LS163 1:XSIG64
44	IS1	@74LS163 1:XSIG24 (AT) @74LS163 1:A
45	IS1	@74LS163 1:XSIG56 (AT) @74LS163 1:XSIG64
46	IS1	@74LS163 1:XSIG56 (AT) @74LS163 1:D
47	IS1	@74LS163 1:XSIG44 (AT) @74LS163 1:XSIG64
48	IS1	@74LS163 1:XSIG44 (AT) @74LS163 1:C
49	IS1	@74LS163 1:XSIG35 (AT) @74LS163 1:XSIG64
50	IS1	@74LS163 1:XSIG35 (AT) @74LS163 1:B

Fig 5—A fault list specifies the faults that it injects into a design. This partial fault list comprises the number, type, and location of the faults in the circuit in Fig 2. This simulator abbreviates the fault types as OS1 for an output S-A-1 (stuck-at-one) fault, OS0 for an output S-A-0 (stuck-at-zero) fault, IS1 for an input S-A-1 fault, and IS0 for an input S-A-0 fault.

HARD-DETECTED-FAULT LIST

FAULT NUMBER	TYPE	TIME	GOOD STATE	FAULTY STATE	LOCATION
8	OS0	750	0001011110 0000	...0.....	@74LS163 1:XSIG32
9	OS0	1650	0100011110 0000	.0.....	@74LS163 1:XSIG54
10	OS1	1050	0010011110 0000	.1.....	@74LS163 1:XSIG54
13	OS1	900	0001111110 0000	...0.....	@74LS163 1:XSIG22
17	IS1	450	0000011000 0000	.1.....	@74LS163 1:XSIG50 (AT) @74LS163 1:O1
18	IS1	2850	0000010110 1111	.1.....	@74LS163 1:XSIG50 (AT) @74LS163 1:XSIG46
26	IS1	450	0000011000 0000	.1.....	@74LS163 1:XSIG39 (AT) @74LS163 1:O2
27	IS1	1650	0100011110 0000	.1.....	@74LS163 1:XSIG39 (AT) @74LS163 1:XSIG36
29	IS1	750	0001011110 0000	...1.....	@74LS163 1:XSIG8 (AT) @74LS163 1:XSIG2
30	IS1	450	0000011000 0000	...1.....	@74LS163 1:XSIG29 (AT) @74LS163 1:O3
31	IS1	1050	0010011110 0000	...1.....	@74LS163 1:XSIG29 (AT) @74LS163 1:XSIG28
34	IS0	750	0001011110 0000	...0.....	@74LS163 1:XSIG26 (AT) @74LS163 1:XSIG30
36	IS0	1650	0100011110 0000	.0.....	@74LS163 1:XSIG47 (AT) @74LS163 1:XSIG51
38	IS0	1200	0010111110 0000	..0.....	@74LS163 1:XSIG37 (AT) @74LS163 1:XSIG39
39	OS0	600	0000111110 0000	...0.....	@74LS163 1:XSIG12
42	IS1	900	0001111110 0000	...1.....	@74LS163 1:XSIG40 (AT) @74LS163 1:XSIG32

Fig 6—A hard-detected-fault list (such as the one shown here for the simulation of Fig 2's circuit) comprises the number, type, and time of detection of the faults; lists the good and faulty outputs for the design under simulation; and pinpoints the location of the faults.

A test-vector set that provides low fault coverage is inadequate for detecting manufacturing defects during production testing.

POTENTIALLY DETECTED FAULT LIST					
FAULT NUMBER	TYPE	TIME	GOOD STATE	FAULTY STATE	LOCATION
11	OS0	300	0000010000 0000	****	@74LS163 1:CLKIN
12	OS0	300	0000010000 0000	****	@74LS163 1:XSIG22
16	IS0	300	0000010000 0000	****	@74LS163 1:XSIG4 (AT) @74LS163 1:XSIG22
19	IS1	300	0000010000 0000	*	@74LS163 1:XSIG50 (AT) @74LS163 1:XSIG4
28	IS1	300	0000010000 0000	*	@74LS163 1:XSIG39 (AT) @74LS163 1:XSIG4
32	IS1	300	0000010000 0000	*	@74LS163 1:XSIG29 (AT) @74LS163 1:XSIG4
37	IS0	150	0****01000 0000	0	@74LS163 1:XSIG6 (AT) @74LS163 1:XSIG8
46	IS1	300	0000010000 0000	*	@74LS163 1:XSIG51 (AT) @74LS163 1:XSIG12
55	IS1	300	0000010000 0000	*	@74LS163 1:FFB (AT) @74LS163 1:CLKIN
58	IS0	300	0000010000 0000	*	@74LS163 1:FFD (AT) @74LS163 1:CLKIN

Fig 7—A list of potentially detected faults, (such as this one for the circuit in Fig 2), contains the same categories that the hard-detected-fault list contains, except that the columns for good states and faulty states include unknown values, which are identified with asterisks.

part of the fault list for the circuit in Fig 2.
The next report (Fig 6) contains the hard-detected-fault list (a list of the faults that the simulator detects).

FAULT-COVERAGE REPORT	
STABILIZATION PERIOD	200 nSEC
RUN TIME	2875 nSEC
STROBE START TIME	0 nSEC
STROBE INCREMENT TIME	75 nSEC
NUMBER OF CIRCUIT FAULTS	324
UNDER CONFIDENCE LEVEL	90%
PRECISION LEVEL	10%
AND RANDOM SEED	13
NUMBER OF SELECTED FAULTS	136
NUMBER OF RANDOM FAULTS	67
NUMBER OF HARD DETECTED FAULTS	45
NUMBER OF POTENTIALLY DETECTED FAULTS	10
NUMBER OF UNDETECTED FAULTS	12
HARD-DETECTED-FAULT COVERAGE	67.16%
POTENTIALLY DETECTED FAULT COVERAGE	14.92%
TOTAL FAULT COVERAGE	82.08%

Fig 8—Summarizing the fault-simulation results, the fault-coverage report reveals the fault coverage that your test vectors will provide for your design. A statistical fault simulation of the circuit in Fig 2 finds that the vectors in Fig 3 will uncover 45 hard detected faults, 10 potentially detected faults, and 12 undetected faults. Therefore, the simulation rates the total fault coverage of these test vectors at 82%.

Besides listing the type and location of each fault, the report lists the simulation time during which the fault is detected. The report also lists the states of the outputs of the faulty design and the good design. When a fault is detected during IC testing, you may be able to identify the fault by consulting the output states in the hard-detected-fault list.

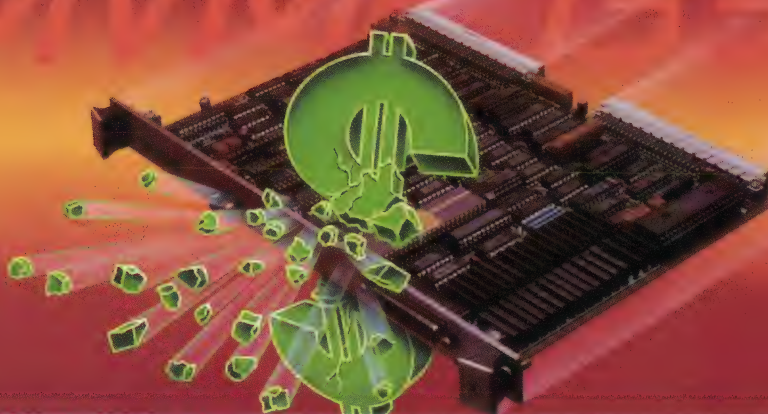
In addition to detected faults, the fault dictionary lists potentially detected faults (Fig 7) and undetected faults. The list of potentially detected faults contains the same categories as the hard-detected-fault list. Because you don't know whether these faults will be detected during testing or not, you use the information in this list for identifying potential design problems. Similarly, the undetected-fault list helps you decide which nodes require additional test vectors.

Finally, the fault simulator produces a summary report of fault coverage (Fig 8). You use this report to determine whether your test-vector set provides adequate fault coverage for your design. For the set of test vectors displayed graphically in Fig 3, for example, a statistical fault simulation set at a 90% confidence level and at 10% precision yields a test coverage of 82%. To achieve higher fault coverage, you need to add vectors to the set. For the design in Fig 2, adding 27 test vectors increases the fault coverage to 98% (Fig 9). Of



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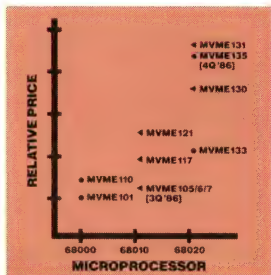
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To minimize the time required to develop a set of test vectors with acceptable fault coverage, you can use a convergent fault simulator.

FAULT-COVERAGE REPORT	
STABILIZATION PERIOD	200 nSEC
RUN TIME	4800 nSEC
STROBE START TIME	0 nSEC
STROBE INCREMENT TIME	75 nSEC
NUMBER OF CIRCUIT FAULTS	324
NUMBER OF SELECTED FAULTS	136
NUMBER OF RANDOM FAULTS	136
NUMBER OF HARD DETECTED FAULTS	119
NUMBER OF POTENTIALLY DETECTED FAULTS	14
NUMBER OF UNDETECTED FAULTS	3
HARD-DETECTED-FAULT COVERAGE	87.50%
POTENTIALLY DETECTED FAULT COVERAGE	10.29%
TOTAL FAULT COVERAGE	97.79%

Fig 9—You can improve the fault coverage provided by Fig 3's test-vector set for the circuit in Fig 2 by adding test vectors. As this fault-coverage report shows, adding test vectors improves the fault coverage of the circuit from 82 to 98%.

this 98% coverage, 88% of the faults are hard detected faults, and 10% are potentially detected faults.

The potentially detected faults are centered in the flip-flop circuitry associated with the preset and clear inputs of the flip-flops. Because these inputs are tied to V_{DD} , you can't change the state of the circuitry, and therefore, you can't produce hard detected faults using test vectors. However, to increase the testability of the design, you can add control signals that connect to the preset and clear lines. These control signals will let you control the states of the flip-flop inputs, thereby increasing the fault coverage.

Some fault simulators provide advanced options that sort through simulation results so you can evaluate your test vector set. Fig 10 gives an example of such an option; it contains a histogram of the percentage of faults detected during a fault simulation. By showing the incremental percentage of faults detected over the time of the fault simulation, the histogram allows you to estimate how much fault coverage you would lose if you were to shorten your test-vector set. Another fault-simulator option facilitates the debugging of devices on the test equipment by allowing you to correlate fault-simulation results with test-equipment results.

Other options for fault simulators enhance the speed of your fault simulation. For example, a technique called "fault collapsing" reduces the number of faults injected into a design during fault simulation, thereby reducing simulation time. This technique analyzes your circuit before simulation and identifies equivalent faults (Ref 1). Equivalent faults are two faults that are logically related: If a set of test vectors detects one fault, you know they can detect the other, so you don't have to test for it. For example, for NAND gate B in Fig 11, if your test vectors can detect an input S-A-0 fault, they can detect an output S-A-1 fault, because if any input remains low, the output must remain high. Because you include only one of each set of equivalent faults, you need to inject only 22 of the 30 possible faults during fault simulation of the circuit in Fig 11.

Besides identifying equivalent faults around gates, advanced fault-collapsing techniques identify equivalent faults between gates. Identifying such equivalent

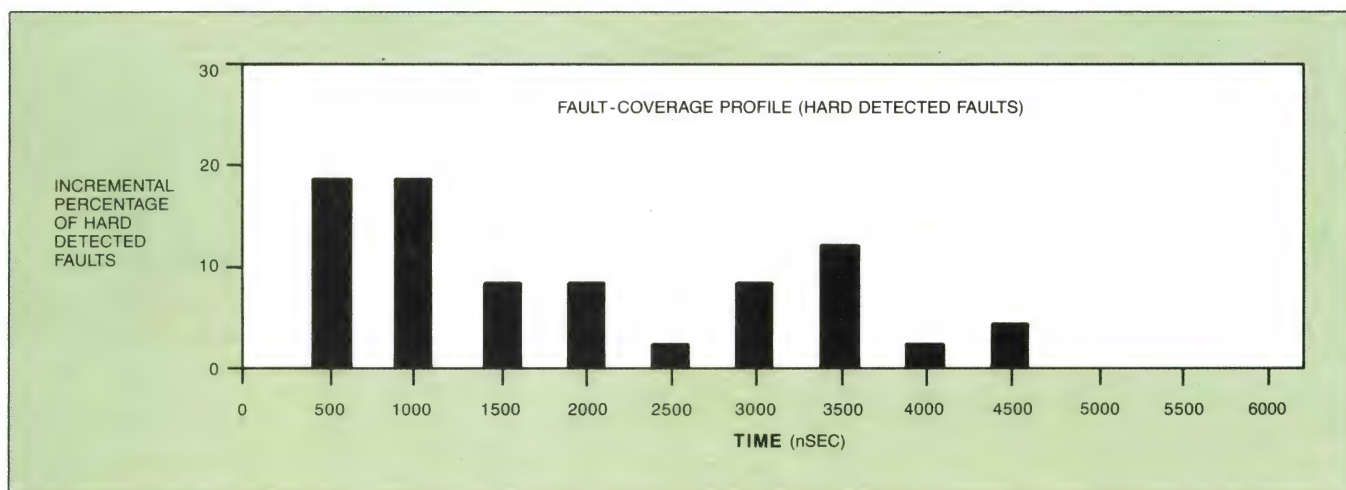


Fig 10—Shortening your test-pattern set results in some loss of fault coverage. A histogram that shows the incremental percentage of hard detected faults allows you to estimate the coverage you will lose by shortening your vector set. This histogram reveals that removing patterns after $t=4500$ would not significantly reduce fault coverage.

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The toggle test generates a report of the percentage of nodes toggled by groups of vectors within your vector set.

faults further reduces the number of injected faults in **Fig 11** from 22 to 16. For the circuit in **Fig 2**, fault-collapsing techniques would reduce the number of injected faults from 324 to 136.

Another method of reducing simulation time is to use a hardware accelerator. The hardware accelerator contains simulation algorithms that are implemented in hardware instead of being coded in software, so it completes simulations much faster than can a general-purpose computer running simulation software. To take maximum advantage of a hardware accelerator, you must make sure the accelerator is compatible with your

simulation system's modeling database.

Finally, note that the circuit information you use during your fault simulation must be identical to the information used during schematic capture, logic simulation, and timing analysis. Obviously, if the circuit models you use to perform logic simulation are different from those you use to perform fault simulation, you can't be sure that the fault coverage you determine will apply to the circuit you eventually fabricate. Although the integrity of the input data (that is, how accurately it represents your design) doesn't affect the performance of the simulation, it is critical for obtaining fault simulation results that are meaningful for the circuit you have designed and verified.

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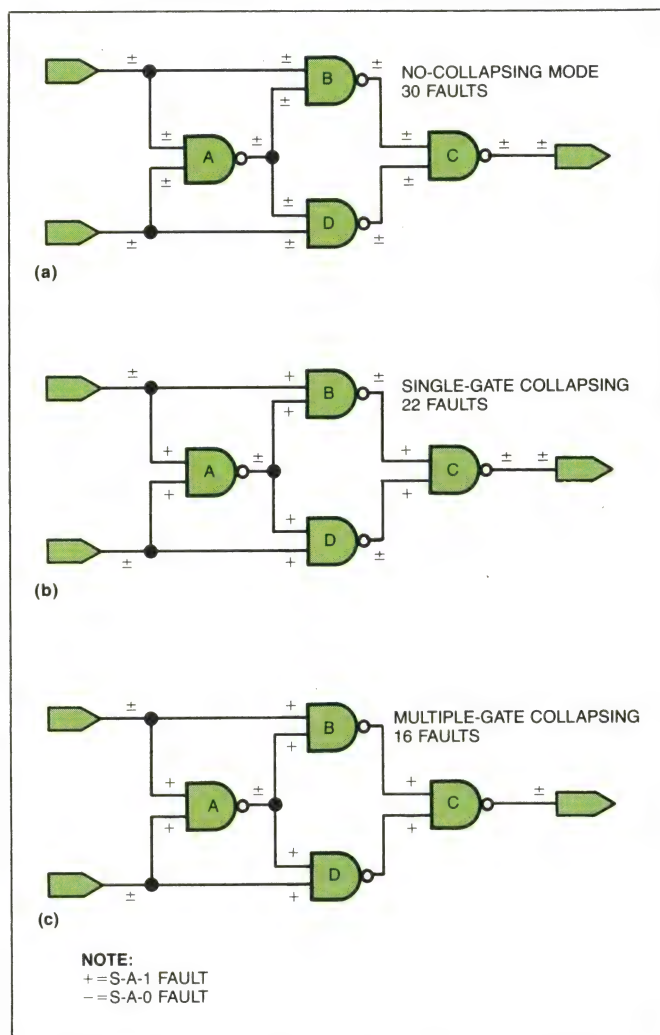


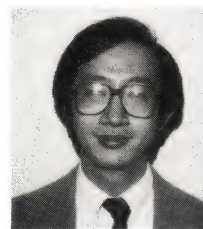
Fig 11—Fault collapsing reduces simulation time by removing equivalent faults (faults that are logically related). Fault collapsing of the equivalent faults around gates reduces the number of possible faults from 30 (a) to 22 (b). Multiple-gate fault collapsing, which finds equivalent faults between gates, further reduces the number of faults to 16 (c).

References

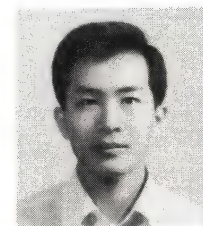
1. Breuer, M A and A D Friedman, *Diagnosis and Reliable Design of Digital Systems*, Computer Science Press Inc, Rockville, MD, 1984.
2. McDermott, R M, *Random Fault Analysis*, Proceedings of the 18th Design Automation Conference, June, 1981, pg 360.

Authors' biographies

Geoffrey Indrajo is a product manager in the Digital Design Automation division of Daisy Systems Inc (Mountain View, CA). Prior to joining Daisy, Geof held marketing positions with Megatest and Hewlett-Packard. He holds a BS and MS in electrical engineering from the University of Maryland and an MBA from Carnegie-Mellon University. Geof, who was born in Indonesia and lived in Hong Kong for 10 years, enjoys travel.



Laung-Terng Wang, now with Aida Corp, was a project leader in Daisy Systems Inc's Digital Design Automation division when he worked on this article. Prior to joining Daisy, he worked as an IC-design engineer at Intel. Laung-Terng holds a BSEE from National Taiwan University and an MSEE from Stanford University. He is currently working on a PhD at Stanford University. In his spare time, he enjoys jogging and travel.



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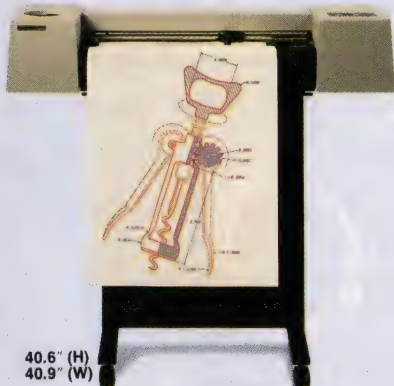
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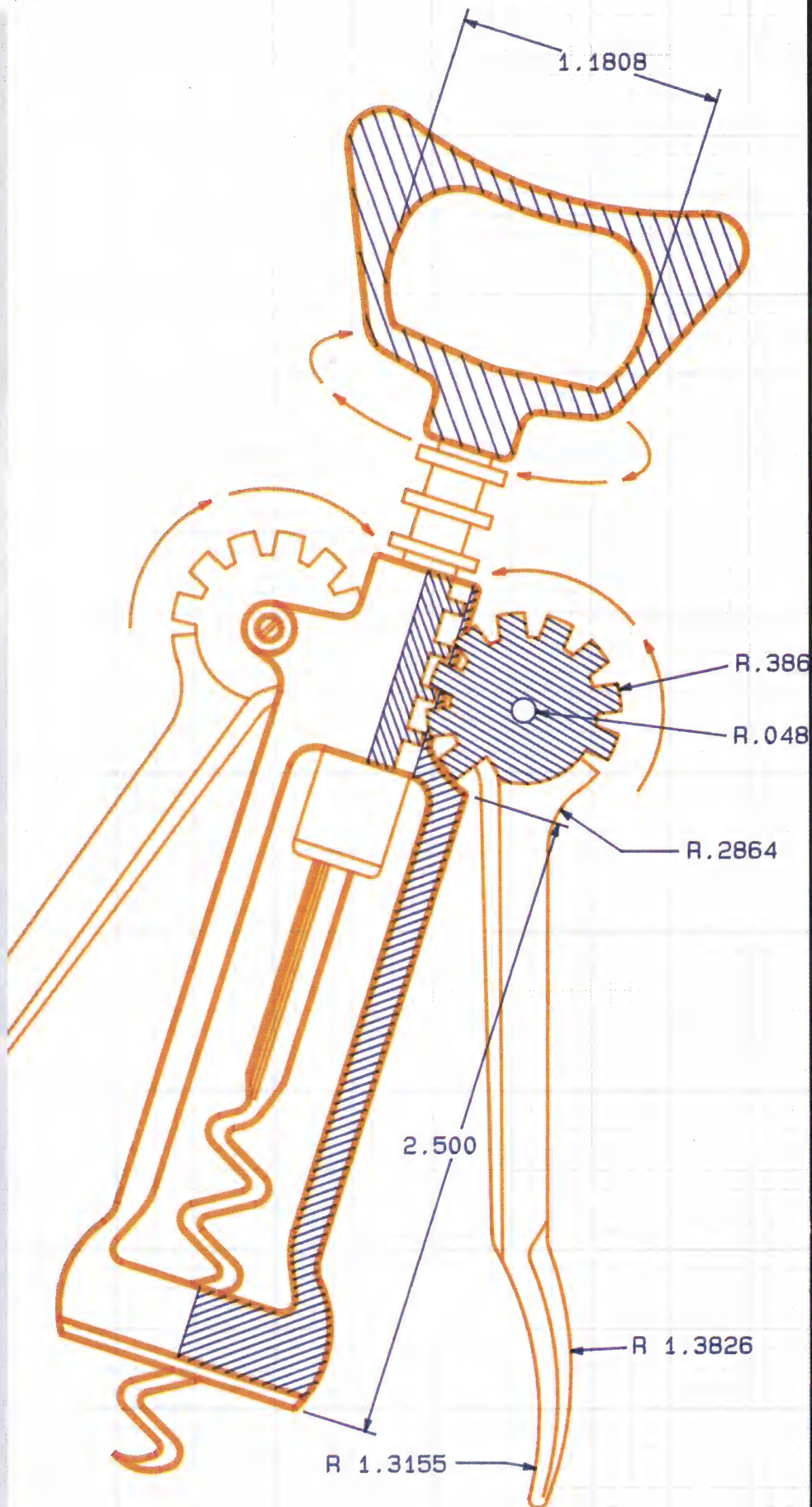


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Current-mirror FETs cut costs and sensing losses

Power MOSFETs that set aside a portion of their source cells for current-sensing purposes allow you to monitor the FETs' total drain current without the need to insert high-power, loss-producing resistors in series with the load current. To use these devices most effectively, you should understand the sensing current's behavior.

Gary Fay, *Motorola Semiconductor Products*

If you pay attention to certain application rules, a power MOSFET having a current-mirror structure can allow you to accurately monitor the total load current provided by the MOSFET without inserting sensing resistors in series with the load. Traditional sensing schemes, which use MOSFETs lacking the current-mirror sense cells, require expensive, high-power wire-wound types of sensing resistors. Moreover, the voltage drop across the sensing resistor represents wasted power.

For a range of sense-resistor values, the current provided by the current mirror can accurately reflect the current in the main power portion of the MOSFET if you understand how this mirror current behaves. Fig

1 shows the circuit that generates the sense voltage. A decoupling effect, arising from the source-follower action in the current-mirror circuit, results in an apparent current ratio that's different from the theoretical design ratio.

The difference stems from the sense resistor, whose value also affects accuracy over temperature. By knowing how the adjusted ratio behaves and how to calculate it, you can easily obtain an accurate representation of the load current, both at ambient temperatures and over the circuit's operating-temperature range. For the schematic in Fig 1a, the linear-region drain-current

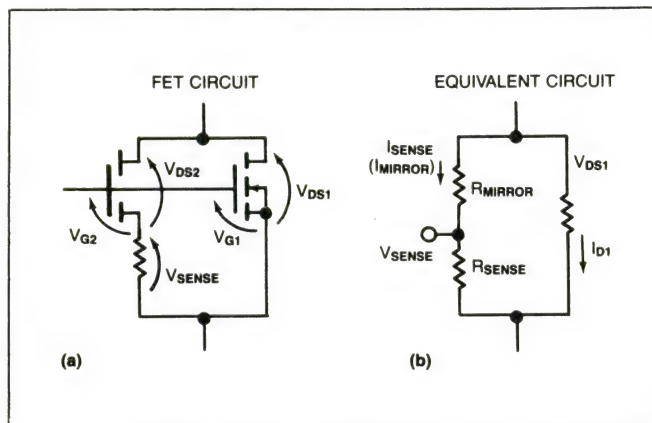


Fig 1—These equivalent circuits help to understand current mirroring in a sense-cell power MOSFET. The impedance in the source leg of the current-mirror FET causes the apparent current ratio between the mirror and power portions of the device to differ from the theoretical value.

When you use a current-mirror MOSFET's sense terminal to monitor current in the device's power portion, take into account the errors introduced by the sensing voltage.

equation (square-law model) gives the source-follower effects of the current mirror:

$$I_D = 2K \{(V_G - V_T) V_{DS} - \frac{1}{2} V_{DS}^2\}$$

$$V_{DS2} = V_{DS1} - V_{SENSE}$$

$$V_{G2} = V_{G1} - V_{SENSE}$$

If you substitute V_{DS2} 's and V_{G2} 's expressions in the square-law equation and perform some factoring, you obtain

$$I_{SENSE} = 2K \{(V_{G1} - V_T - V_{SENSE})(V_{DS1} - V_{SENSE}) - \frac{1}{2}(V_{DS1} - V_{SENSE})^2\}. \quad (1)$$

Eq 1 expresses the sense current in terms available to the user: specs of the power MOSFET. Note that Eq 1 includes the value of the sense voltage. Because the sense current is a function of the sense voltage, it's necessary to include this term in order to accurately reflect the current in the power transistor. You can determine the dependence of the current-mirror ratio on the operating conditions by deriving the ratio of the current in the power transistor to the current in the current-mirror transistor:

$$n' = \frac{2K_P \{(V_{G1} - V_T)V_{DS1} - \frac{1}{2}V_{DS1}^2\}}{2K_S \{(V_{G1} - V_T - V_{SENSE})(V_{DS1} - V_{SENSE}) - \frac{1}{2}(V_{DS1} - V_{SENSE})^2\}} \quad (2)$$

In Eq 2, K is a function of the design of the FET; in fact, K reflects the source periphery dimensions. The ratio K_P/K_S becomes the impedance ratio Z_P/Z_S , an easily measurable quantity for the power-MOSFET designer. This ratio is, in fact, the current-mirror ratio

(n) specified in the data sheet. The above expression thus reduces to a simpler version:

$$n' = \frac{n}{1 - \frac{V_{SENSE}(V_{G1} - V_T - \frac{1}{2}V_{SENSE})}{V_{DS1}(V_{G1} - V_T - \frac{1}{2}V_{DS1})}} \quad (3)$$

For low-voltage devices, in which V_{SENSE} and V_{DS1} are small in comparison with V_{G1} and V_T , the adjusted current-mirror value is approximated by

$$n' = \frac{n}{1 - \frac{V_{SENSE}}{V_{DS1}}} \quad (4)$$

Eq 3 and Eq 4 relate the current-mirror ratio to terms available to—and controlled by—the TMOS power-MOSFET user. V_{DS1} is the $R_{DS(ON)}$ of the selected MOSFET times the load current, V_{G1} is the applied gate voltage, and V_T is the threshold voltage—either measured (for greatest accuracy), or as specified in the data sheet. V_{SENSE} is set by the sense resistor's value and the sense current, which is the load current divided by the adjusted current-mirror ratio (n'):

$$V_{SENSE} = \frac{R_{SENSE} I_{LOAD}}{n'}$$

Eq 4 shows that, as the sense voltage increases relative to the $V_{DS(ON)}$ of the power portion of the MOSFET, the denominator decreases and the observed current-mirror ratio increases. Eq 4 also indicates that, as V_{SENSE} approaches V_{DS1} , a meaningless ratio develops. The ratio becomes meaningless because the drain-source voltage of the mirror cell decreases, thereby increasing the cell's resistance and reducing the mirror current.

In fact, you reach a point of diminishing returns when you make the value of the sense resistor too high because the sense-cell transistor merely becomes a switch that connects the power FET's $V_{DS(ON)}$ to the sense resistor. The plot in Fig 2 shows the effects of increasing the value of the sense resistor. Note that, as the sense resistor's value increases, the sense voltage approaches the power device's $V_{DS(ON)}$.

Fig 3 shows the sense-voltage accuracy (over 25 to 125°C) as a function of the sense resistor's value. As R_{SENSE} increases, the sense-voltage accuracy approaches the $R_{DS(ON)}$ temperature variation in the power device. To obtain high accuracy over thermal excursions, you must use a low-value sense resistor.

Experimenting with two different cases, or exam-

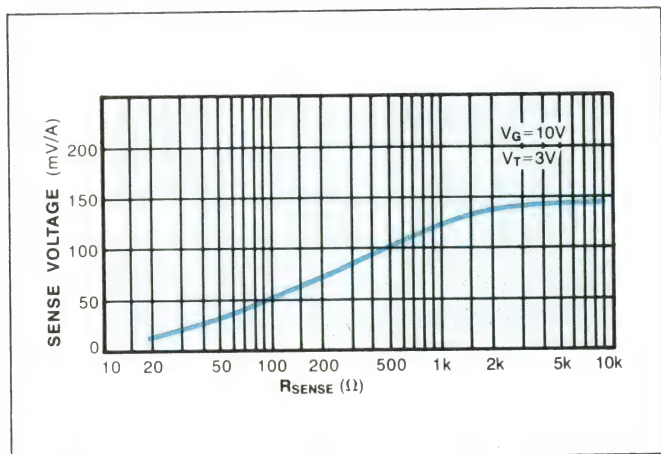


Fig 2—As you increase the sense resistor's value in a current-mirror circuit, the sense voltage also increases. This increase subtracts from the mirror cell's drain-source voltage, thereby increasing the cell's equivalent resistance. This increase in resistance causes a decrease in mirror current—hence an increase in the mirror-current ratio.

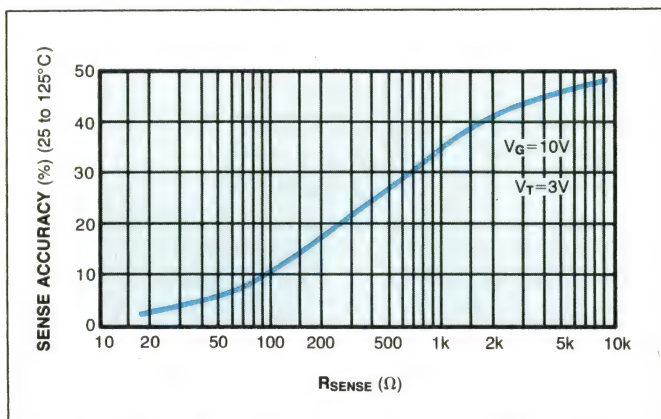


Fig 3—Temperature stability plunges as the sense resistor's value in a current-mirror circuit increases, as borne out by this curve. The sense-voltage accuracy over 25 to 125°C degrades from 10 to 40% when the sense resistor increases from 100 to 1500Ω.

ples, of designing with current mirrors will aid in your understanding. Assume you must obtain a current-limit signal at 10A load current, and you're using a device that has a mirror design ratio of 1800, an on-resistance of 0.15Ω, a threshold voltage of 3V, and a gate on-voltage of 10V. For the first case, select the sense voltage (at 10A) to be 0.3V; for the second case, set the sense voltage at 0.75V. You can now determine the mirror-ratio value from

CASE 1

$$n' = \frac{1800}{1 - \frac{0.3(10 - 3 - 0.15)}{1.5(10 - 3 - 0.75)}} = 2305$$

CASE 2

$$n' = \frac{1800}{1 - \frac{0.75(10 - 3 - 0.375)}{1.5(10 - 3 - 0.75)}} = 3830$$

Next, calculate the sense-resistor value:

CASE 1

$$R_{\text{SENSE}} = \frac{0.3(2305)}{10} = 69.2\Omega$$

CASE 2

$$R_{\text{SENSE}} = \frac{0.75(3830)}{10} = 287\Omega$$

Thus, a standard-value carbon resistor of 68Ω±5% for the first case, and 300Ω for the second case, would be suitable for the sense resistor. This procedure completes the selection of the sense-resistor value, unless you need to know the sensing variations with thermal excursions.

For thermal results, obtain the on-resistance varia-

tion of the power FETs from the values shown in the data sheet (generally presented in the on-resistance vs drain-current curve). For a fixed load current (ie, 10A), the on-voltage will also change by the same percentage. For this example, assume the FET's on-resistance increases by 50% from 25 to 125°C; you also need to know the effect this variation has on the sense voltage. The on-resistance of the mirror transistor is the device's V_{DS} divided by its current:

$$R_{\text{MIRROR}} = \frac{V_{\text{DS1}} - V_{\text{SENSE}}}{\frac{V_{\text{SENSE}}}{R_{\text{SENSE}}}} \quad (5)$$

Eq 5 shows that this resistance must increase by 50%, as does the V_{DS1} of the power device, because of its $R_{\text{DS(ON)}}$ increase. The sense voltage at 125°C is the sense current times the sense-resistor value:

$$V_{\text{SENSE}} = \frac{R_{\text{SENSE}} V_{\text{DS1}}}{R_{\text{MIRROR}} + R_{\text{SENSE}}}$$

CASE 1

$$R_{\text{MIRROR}} = \frac{1.5 - 0.3}{\frac{0.3}{69.2}} = 276.8\Omega$$

CASE 2

$$R_{\text{MIRROR}} = \frac{1.5 - 0.75}{\frac{0.75}{287.1}} = 287.1\Omega$$

$$\text{AT } 125^\circ\text{C: } R_{\text{MIRROR}} = 415.2\Omega \\ V_{\text{DS1}} = 2.25\text{V}$$

$$R_{\text{MIRROR}} = 430.7\Omega \\ V_{\text{DS1}} = 2.25\text{V}$$

$$V_{\text{SENSE}} = \frac{69.2(2.25)}{415.2 + 69.2} = 0.321\text{V}$$

$$V_{\text{SENSE}} = \frac{287.1(2.25)}{430.7 + 287.1} = 0.899\text{V}$$

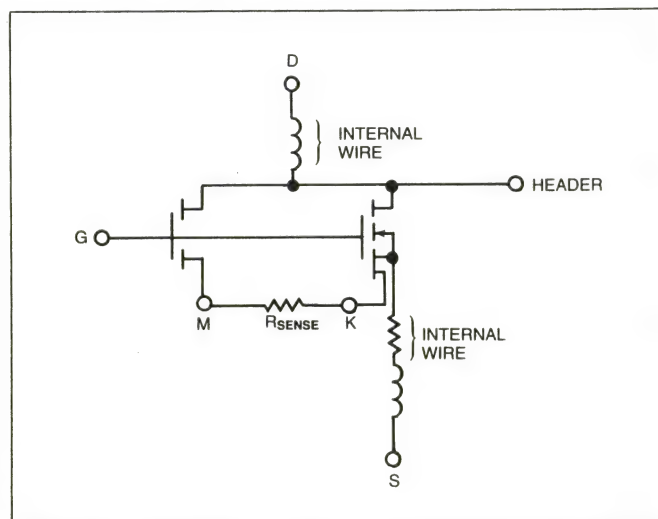


Fig 4—Parasitic resistance and inductance in a sense-cell power MOSFET can lead to serious measurement errors, if you don't take proper precautions. You must be careful to use Kelvin connections and to avoid ground loops in the return paths of the supplies and measuring equipment.

By using temperature-dependency specs from the sense-cell FET's data sheet, you can calculate the dependency of the current-mirror ratio on temperature.

These calculations demonstrate that, when the sense voltage is 20% of the power device's on-voltage, a 7% variation (0.321V vs the selected 0.3V) in sense voltage arises from thermal effects. However, a 20% variation (0.899V vs 0.75V) is seen when the sense voltage is 50% of the on-voltage, as borne out by **Fig 3**.

Therefore, if you can't tolerate large thermal variations in your system design, you must keep the sense voltages low in relation to the power FET's on-voltage. Further, you must use amplifier stages to increase the

sense-voltage levels to those required in the system design.

To obtain accurate results when sensing currents, you must observe some precautions. When you're measuring milliamperes of sense current in the presence of amperes of power current, you must follow good lab-wiring practices. These practices involve using Kelvin contacts and differential measurements to eliminate line drops and—more important—eliminating the effects of ground loops between supplies and measuring

Source cells provide lossless sensing

The development of cellular structures having separate source sites has paved the way for many improvements in power MOSFETs. For the most part, these improvements have accrued from tailoring surface geometries to obtain optimal spacings, minimum die size, and lowest cost for a given breakdown voltage.

In a power FET, all the separate source cells are connected in parallel by means of the top surface metal. The load current splits equally among all the cells because the cells are basically equal-value resistors in parallel.

By separating one or more of these sense cells, you can obtain a sample of the load current and divert this sample through a sensing network. Because the power MOSFETs have thousands of cells conducting amperes of current, the sense network (which has only a few cells) conducts only a fraction—in fact, a few milliamperes—of the total current.

In essence, the sense current "mirrors" the total drain current. You can thus use small, low-value resistors (typically, $\frac{1}{8}$ W, 40 to 100 Ω film types) to develop a sense voltage from

this mirror current. These small, low-cost resistors contrast sharply with the large, expensive resistors (typically 10W, 0.1 Ω wirewound types) you'd insert in series with the load current to sense current in FETs lacking the sense cells.

Fig A shows the layout of Model MTP10N10M, the first of a family of TMOS current-mirror devices, dubbed Sense FETs. **Fig B's** photomicrograph gives an expanded view of the FET's current-mirror portion. For this device, two of the 3600 source cells in the die are separated and wired to an isolated pad.

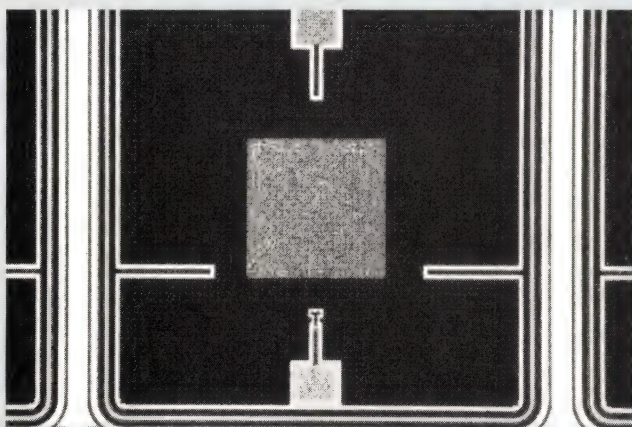


Fig A—A photomicrograph of the MTP10N10M, the first device in a series of sense-cell MOSFETs, shows the separate source contact used for current sensing.

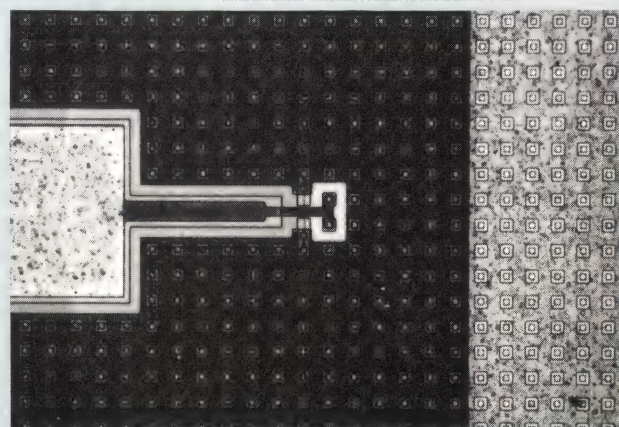


Fig B—Zooming in on the sense-cell connection to **Fig A's** die, this photomicrograph shows the contact to two sense cells—two cells out of the total 3600 source cells.

equipment. These precautions are important not only in benchtop circuitry and pc-board wiring, but also in the internal connections of the power MOSFET itself. Fig 4 shows a sense-cell FET's internal components and external connections.

The resistance of wire bonds and package leads in typical TO-220 packages can amount to 5 to 10 m Ω , a range that produces 0.05 to 0.1V drop at 10A. Although these values are not significant in relation to applied gate voltages, they can be a substantial source of error for the sense circuit, especially if sense voltages are low (0.1 to 0.2V), as required for minimum thermal variations.

Fig 5's scope photos dramatically illustrate these errors. For both photos, a 576 curve tracer drives the TMOS power device, and an X-Y oscilloscope monitors the device's sense and drain-source voltages. The photo in Fig 5a shows the sense voltage obtained without using Kelvin contacts; Fig 5b shows the same voltage, measured at the die, using the Kelvin contacts provided in the current-mirror MOSFET.

In Fig 5a, notice how the sense voltage exceeds the load line (drawn in on the photo); note also that the 20V gate-drive signal extends to 65 mV. In Fig 5b, however, note that the maximum voltage with 20V gate drive

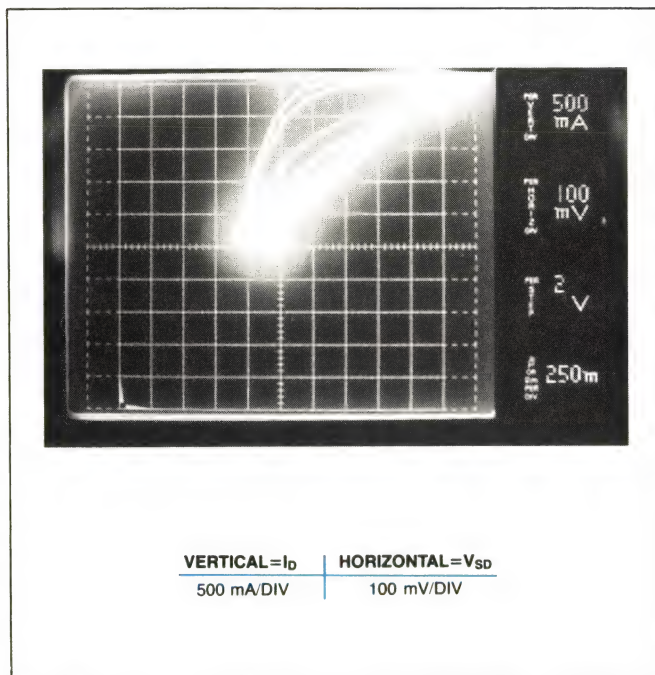


Fig 6—Before a MOSFET's intrinsic source-drain diode takes over, the FET still acts like a FET, and is under full control of the gate-source signal. The current-mirror cells in a sense-cell MOSFET operate normally, too, in this limited reverse-voltage region.

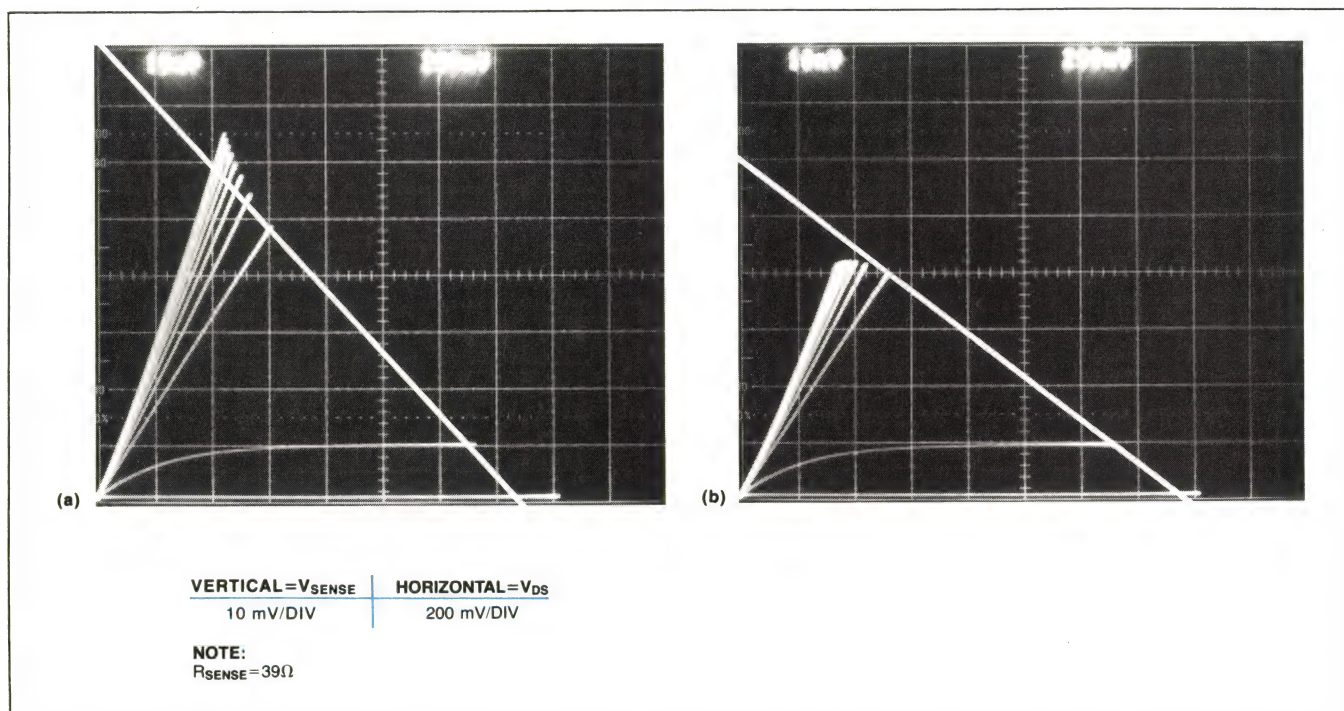


Fig 5—Failure to use Kelvin connections can lead to substantial errors, as these scope photos bear out. For a, no Kelvin contacts were used; note how much higher the sense voltages are than in b, whose curves reflect the use of the Kelvin connections.

Be sure to use Kelvin contacts and eliminate the effects of ground loops when you're monitoring heavy load currents.

is only 42 mV—for this example, a difference of 55%. Also note in **Fig 5b** that the sense voltage is well below the drawn-in load line. This roll-off from the load line reflects the decoupling afforded by the sense resistor, as predicted by **Eq 4**.

Because n' is greater than the design value n , the current in the sense cells (I_{SENSE}/n') will be lower than that in the remainder of the cells in the power FET. Thus, the sense voltage developed by this current through the sense resistor will be lower than the value indicated by the load line for the power portion of the transistor.

Consider reverse currents

Because the TMOS FET behaves like a voltage-controlled resistor, it will conduct current in either direction. In the reverse direction, when the current becomes great enough, the intrinsic source-drain diode becomes forward biased. Until that forward biasing occurs, the part is still fully under control of the gate voltage, and it exhibits on-voltage and speed characteristics similar to those in the forward direction. Once the diode turns on, it becomes dominant.

Fig 6 shows the reverse characteristics of the power FET. Here, you can see that a low-voltage-drop resistive characteristic is available for such applications as synchronous rectifiers or low-drop freewheeling diodes. Even in these uses, many systems require that you know the value of the load current.

The current-mirror section of a sense-cell MOSFET

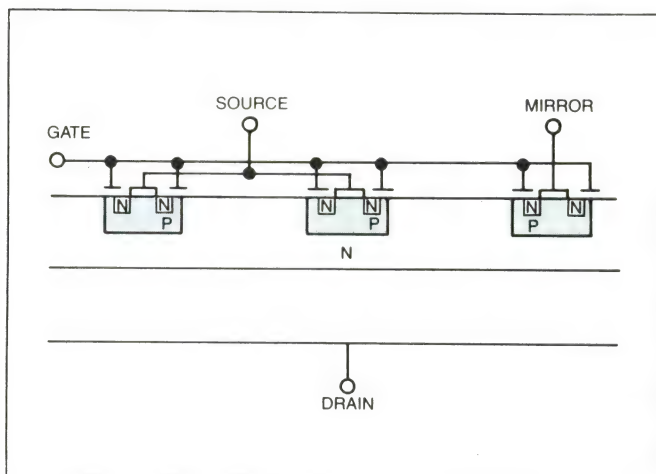


Fig 7—A current-mirror cell in a sense-cell MOSFET has the same construction as the power cells. It thus has the same source-drain reverse diode as do the power cells, and it will reflect a portion of the power-section current in the same way it does in the forward direction.

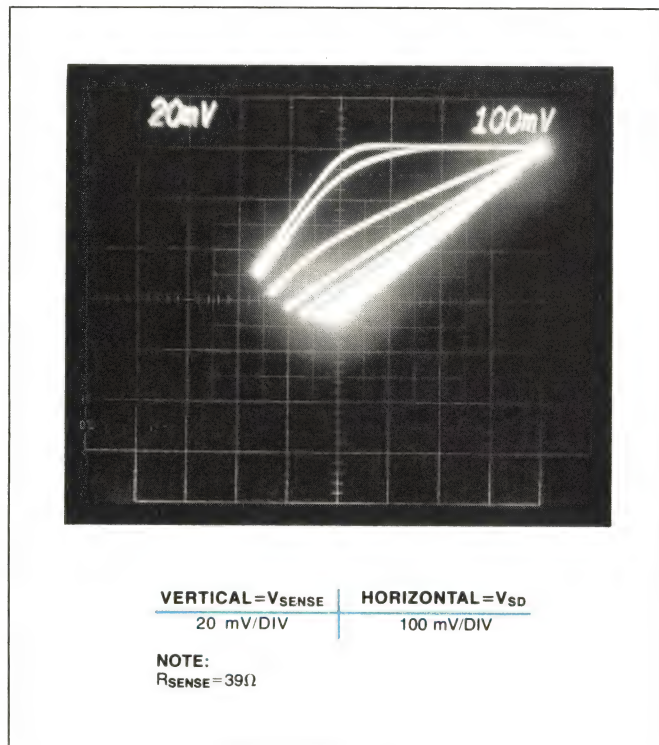


Fig 8—Similar to the curves in **Fig 5**, these V_{SENSE} vs V_{SD} curves show that a sense-cell MOSFET operates similarly in the forward and reverse directions. This fact is only true, however, for the limited voltage range in which the source-drain reverse diode is not conducting.

is constructed in the same way as the rest of the die, as shown in the cross section in **Fig 7**. This section, therefore, also has the reverse diode formed by the P-tub, N-epitaxial junction. The sense cells will thus also reflect the reverse current, just as they mirror current in the forward direction. **Fig 8** shows sense voltage vs drain-source voltage in the reverse direction for the sense-cell FET whose reverse characteristics appear in **Fig 6**. For these curves, the test circuit uses a 39Ω sense resistor. Note the similarity of wave shapes, all impinging on the reverse-diode curve.

When you measure sense-cell FETs, an important thing to remember is never leave an unused source terminal floating. This rule is especially important for the power portion's source when you're measuring the current-mirror portion. If you leave the power source floating and apply more than 10V gate drive and approximately 12V to the drain, then the current-mirror portion will begin to exhibit GemFET (an insulated-gate, conductivity-modulated device) action.

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current can result in destruction of the current-mirror section of the device. You can see the reason for the increase in **Fig 7**, which shows the two connections for the source and mirror terminals. If the source is floating while the mirror is active, then the P tub under the source acts as a collector which, given enough drive, begins to inject carriers in the mirror transistor. This bipolar action quickly drives the mirror currents to levels beyond those that the front metal runs and wire interconnections can tolerate. The best way to measure sense-cell MOSFETs is to use the circuit shown in **Fig 1**.

Use Kelvin for accuracy

If you should need accurate measurements of the drain-source voltage (as it appears on the die), then you can use the Kelvin pins and the header to effect Kelvin contacts. In addition, you must return all signal and sensing leads in the system to the Kelvin contact provided on the MOSFET devices. Use the drain and source pins for power connections.

Inductive effects can present overvoltage spikes to the sense circuit because the internal connections present about 10-nH inductance to load currents. You might have to use capacitors to attenuate these spikes, in addition to using the Kelvin contacts. **EDN**

Author's biography

Gary Fay is Smartpower applications manager at Motorola's Semiconductor Products Sector (Phoenix, AZ). Employed by Motorola for 19 years, he holds a BSEE degree from the University of Cincinnati. Gary has five patents (two granted, three pending).



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High 482 Medium 483 Low 484

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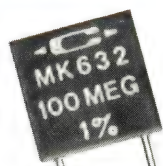
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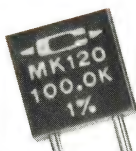
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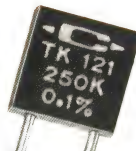
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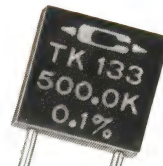
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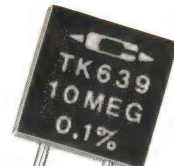
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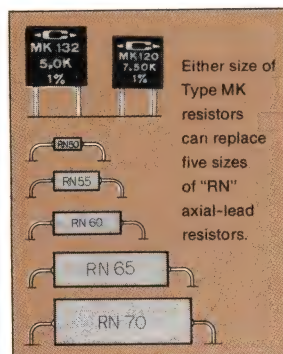


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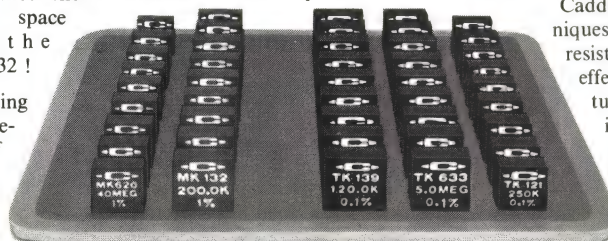
	MK 120	MK 620	MK 132	MK 632
• Resistance Range	30 ohms to 2 Megohms	2.1 Megohms to 40 Megohms	10 ohms to 5 Megohms	5.1 Megohms to 100 Megohms
• Resistance Tolerance	±1.0% is standard, to ±0.1% on special order, depending on value and model.			
• Wattage	0.5 Watt	—	0.75 Watt	—
• Voltage	200 V	200 V	400 V	400 V
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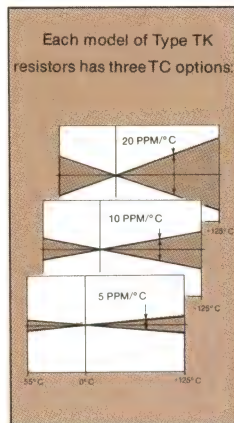
And within their voltage ratings, both sizes of Type MK resistors can replace five sizes of "RN" resistors, including the 1/2 watt "RN 70" which requires 10 times the board space of the MK 132!



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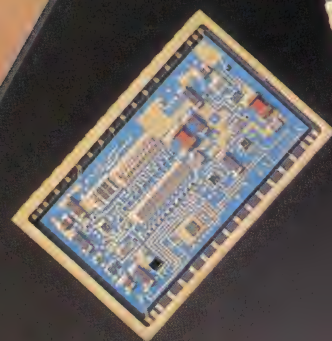
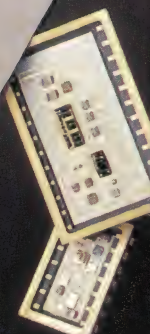
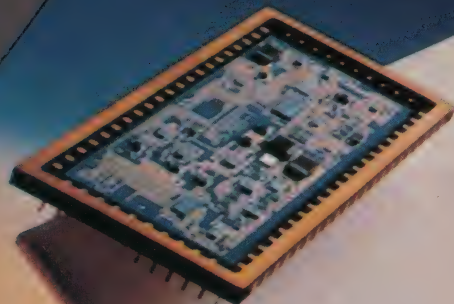
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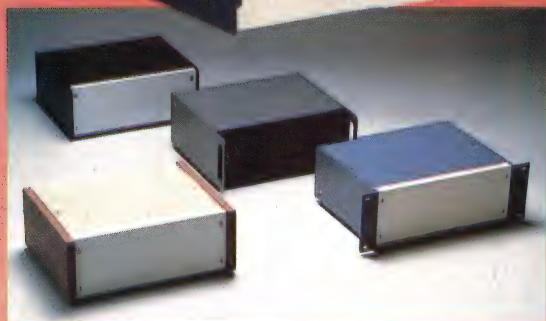
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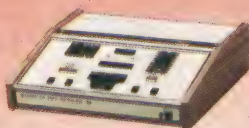
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Latch array provides bank of control words

William Grill

Martin Marietta, Denver, CO

An array of addressable latches provides you with a variable number of digital words of n bits each, all simultaneously active and accessible. **Fig 1** shows the circuitry for 24 words of five bits each; you get one bit per column and eight (or fewer) words per row of devices. In many cases, this approach uses fewer parts than, say, a design involving one register per word. Note that the additional gates needed to meet fan-out requirements have been omitted for the sake of clarity.

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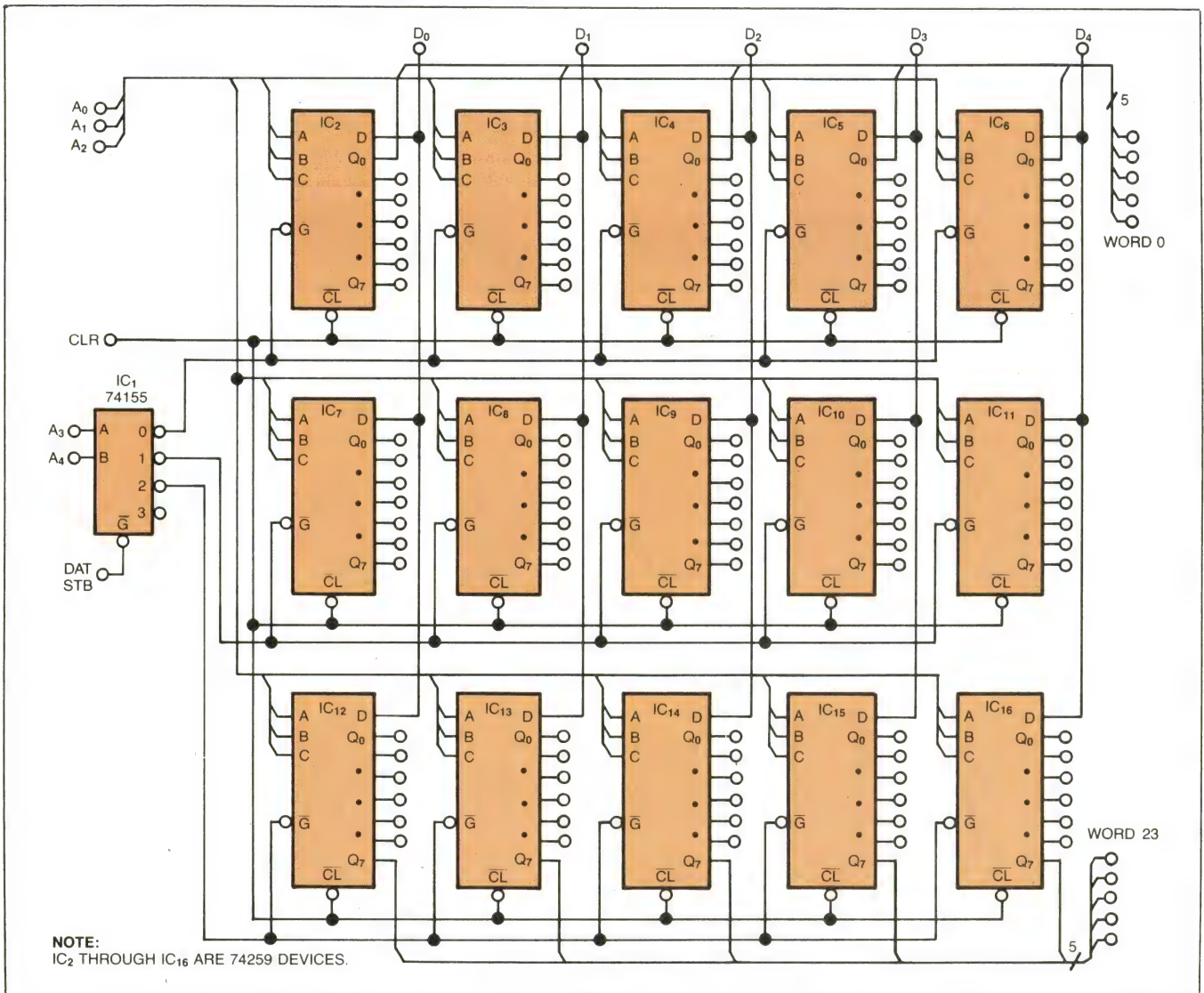


Fig 1—This register array generates a bank of 24 programmable control words, which are useful for driving D/A converters, analog switches, and RF attenuators.

Multiplexers expand 8051's data/code space

A J Nicoll
Intel Corp, Hillsboro, OR

Using three external 4-bit multiplexers, you can add dynamic RAM-refresh capability to your 8051 μ C sys-

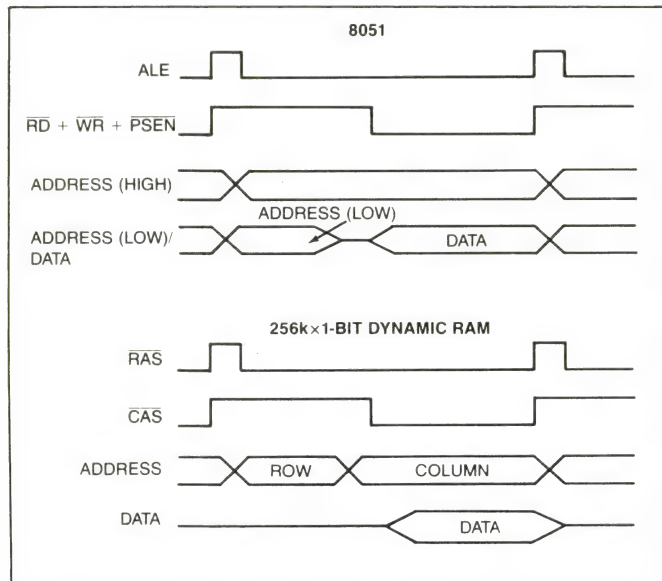


Fig 1—Bus-timing diagrams for the 8051 μ C and a typical dynamic RAM system are very similar.

tem, thereby expanding the data/code memory space to 256k bytes (or more). The enhanced system can support RAM disks and printer buffers, for example, that transfer and store large amounts of data.

The timing diagrams in Fig 1 show that the 8051 and a typical dynamic RAM have similar bus-timing requirements. Therefore, adding multiplexers IC₂, IC₃, and IC₄ (Fig 2) simply changes ALE to $\overline{\text{RAS}}$ and $\overline{\text{WR}}$ to $\overline{\text{WE}}$. In addition, NOR gate IC₅ combines the 8051's RD, WR, and PSEN signals to produce the dynamic RAM's CAS signal.

To refresh the dynamic RAM, a timer interrupt calls a routine consisting of 256 NOP instructions. At a clock frequency of 12 MHz, for example, the NOPs steal 256 μ sec from each 4 msec of code-execution time, reducing throughput by only 7% as a consequence.

This design relies on propagation time through the multiplexers to provide a hold time for the dynamic RAM. If the RAM is too slow, however, or the multiplexers are too fast, you can add a gate delay in the ALE line, as shown by the dotted lines.

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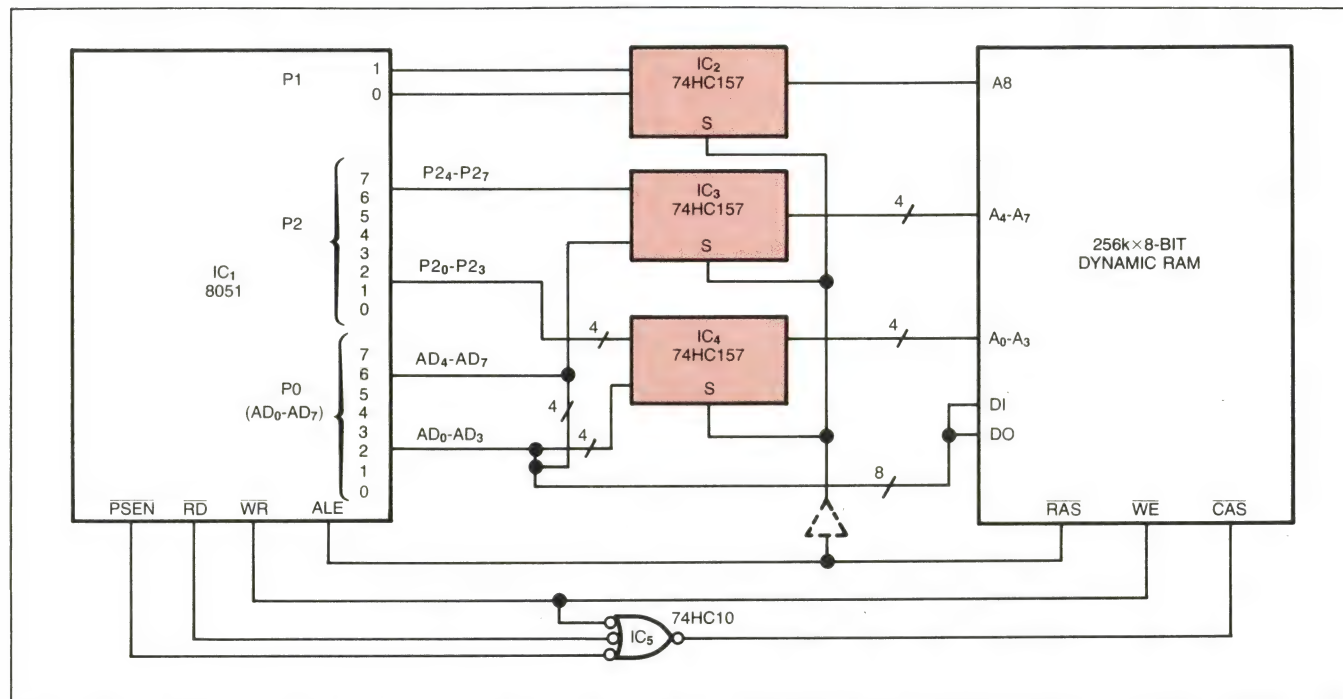
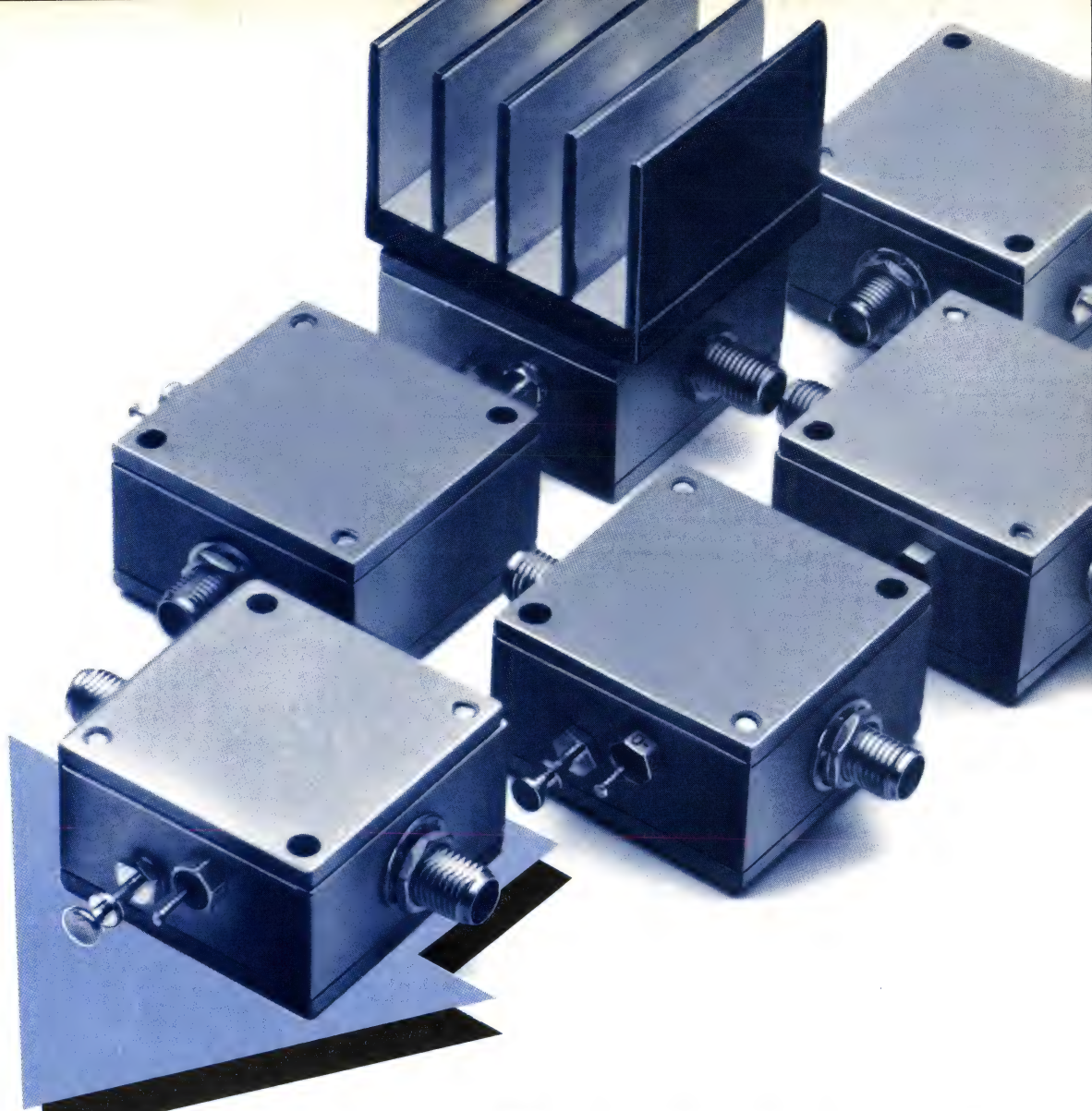


Fig 2—The addition of multiplexers IC₂, IC₃, and IC₄ provides dynamic RAM-refresh capability for an 8051 μ C system.



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AGC circuit uses an analog multiplier

Steve Lubs
Dept of Defense, Washington, DC

In the AGC circuit of Fig 1, a 4-quadrant analog multiplier (IC₁), an amplifier stage (IC₂), an active, full-wave rectifier (D₁, D₂, R₄-R₇, and IC₃), and an integrator (IC₄) accomplish automatic gain control of V_{IN}'s amplitude variations in the audio-frequency range.

The multiplier's output is $-V_{IN}V_Y/10$, where V_Y is a negative voltage generated by the integrator IC₄. Together, the integrator and the rectifier extract the dc component (V_Y) of V_{OUT} for use as a feedback signal to the multiplier. The integrator sums signal current from the rectifier and control current from potentiometer R₉, which lets you adjust V_{OUT}'s signal level.

Circuit analysis yields the frequency-response equation

or, in the time domain,

$$V_{OUT} = \left(\frac{K_1 A V_C}{10 R C_3} \right) \exp \left(- \frac{10 A t}{R C_3} \right).$$

In both equations, K₁ is the gain of amplifier IC₂, A is the peak amplitude of V_{IN}, and R is the resistance between the integrator input and the rectifier output. (For this circuit, R equals R₆ in parallel with R₇.)

This AGC circuit is suitable for controlling long-term variations of amplitude within a limited range. It doesn't respond uniformly over a wide dynamic range, however, because the time response is inversely proportional to input-signal amplitude. **EDN**

$$V_{OUT} = \frac{K_1 A V_C}{10 R C_3} \left(\frac{1}{s + \frac{10 A}{R C_3}} \right),$$

To Vote For This Design, Circle No 749

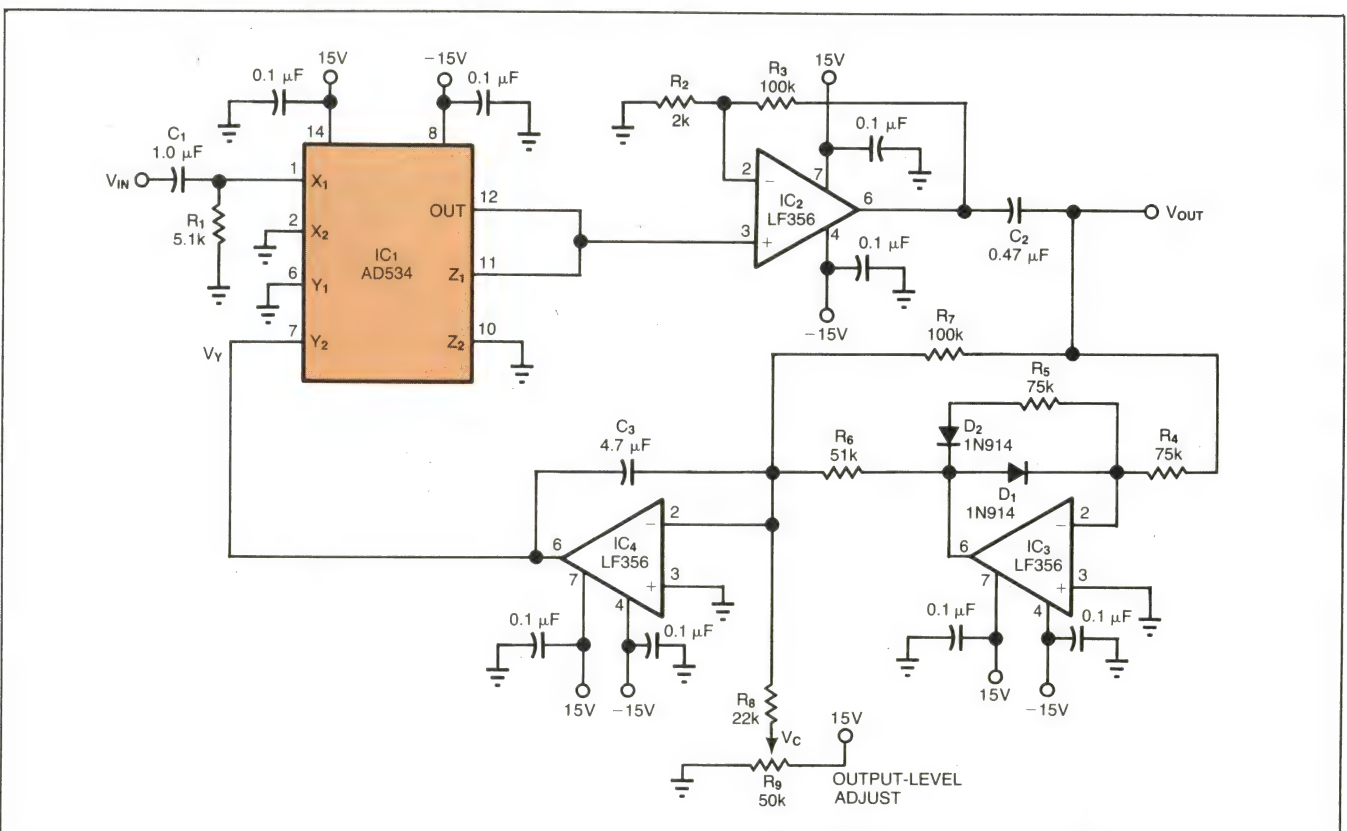


Fig 1—Analog multiplier IC₁ combines V_{IN} with a feedback signal V_Y to achieve automatic gain control.



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CIRCLE NO 217

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IC emulates many types of logic gates

Kurt W Christner
Carson City, NV

Normally, you'd use a 4053-type triple-spdt analog switch (also called a triple, 2-channel analog multiplexer/demultiplexer) for analog signal-switching applications. When properly connected, however, the CMOS device can also emulate a variety of simple gates and flip-flops. What's more, you can save space with a 4053 by packing three types of simple logic gates into one DIP.

Fig 1, for example, shows the 4053's implementations and truth tables for eight logic functions. The inverter, buffers, and gates use one spdt section each; the flip-flops use two sections each. Note that the buffers

are bidirectional because the 4053's input-to-output path is a symmetrical transmission gate. Also, unlike conventional buffers, they have an output impedance (on-resistance) of several hundred ohms.

In **Fig 2**, the 2-input gates require the complement of one input; if the complement isn't available, though, you can generate it using a $\frac{1}{3}$ 4053 as an inverter. The circuits of **Fig 1** and **Fig 2** will work with the V_{EE} terminal connected either to ground or to a negative supply voltage, provided that the 4053 and the external logic are operating from the same V_{DD} and V_{SS} supply levels. (*Ed Note: The 4053 requires supply voltages (V_{DD} and V_{SS} , pins 16 and 8), plus a bias supply (V_{EE} , pin 7).*)

The level-shifting circuits of **Fig 3** shift the A_{IN} signal

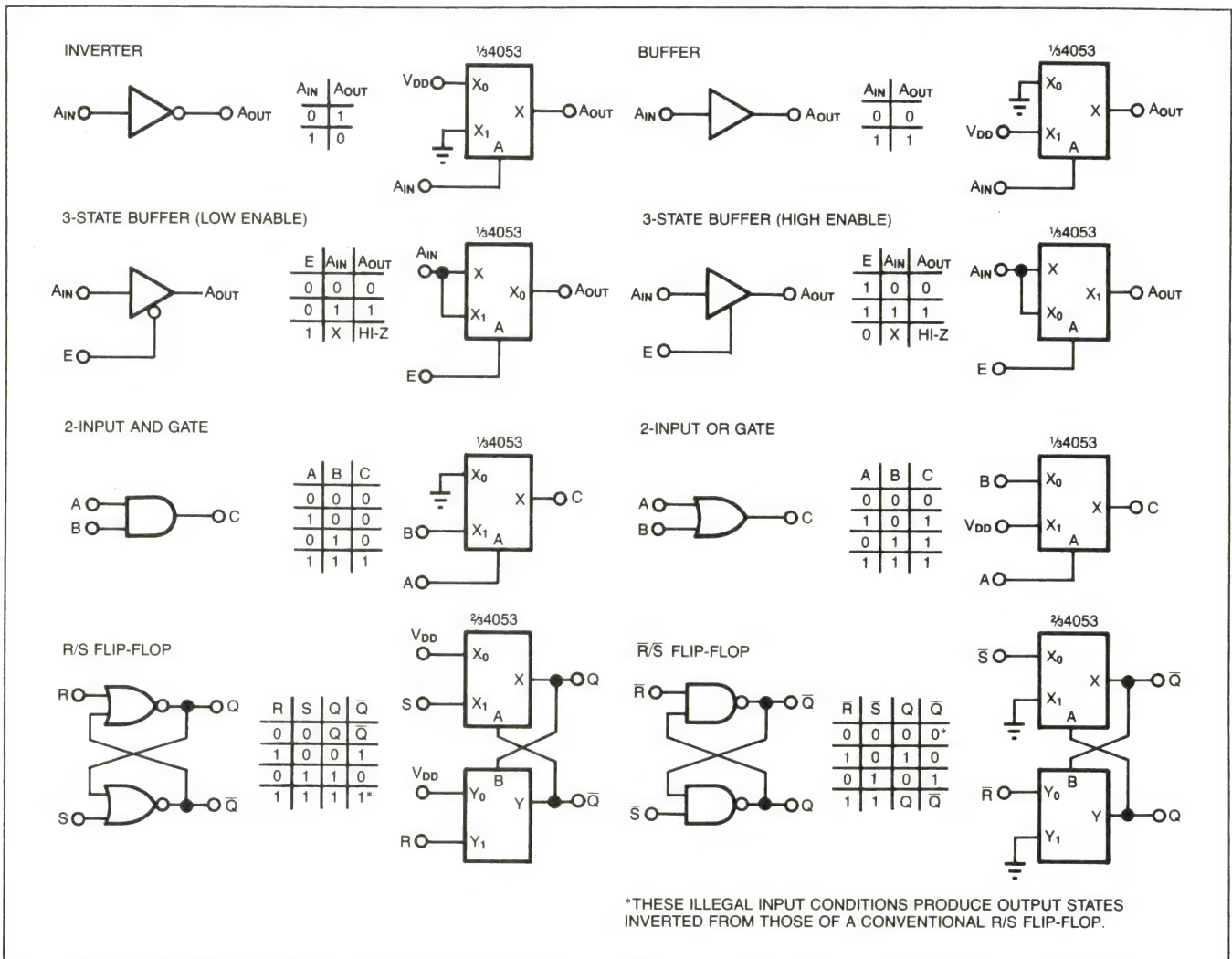


Fig 1—You can implement each of these eight digital functions with one 4053-type analog multiplexer.



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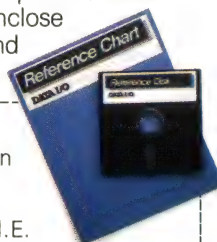
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CIRCLE NO 218

DATA I/O

DESIGN IDEAS

from V_{SS} - V_{DD} levels to V_{EE} - V_{SS} or V_{EE} - V_{DD} levels. V_{EE} must connect to a negative supply voltage in these circuits.

In these applications, the 4053's inhibit input (pin 6) must connect to V_{SS} . Also, the response of the 4053-based circuits is generally slower than that of equivalent CMOS digital gates. Even though the 4053's propa-

gation delay from switch input to switch output is faster—about one-fifth that of a CMOS gate—the delay from a 4053 control input is approximately twice that from a CMOS-gate control input.

EDN

To Vote For This Design, Circle No 748

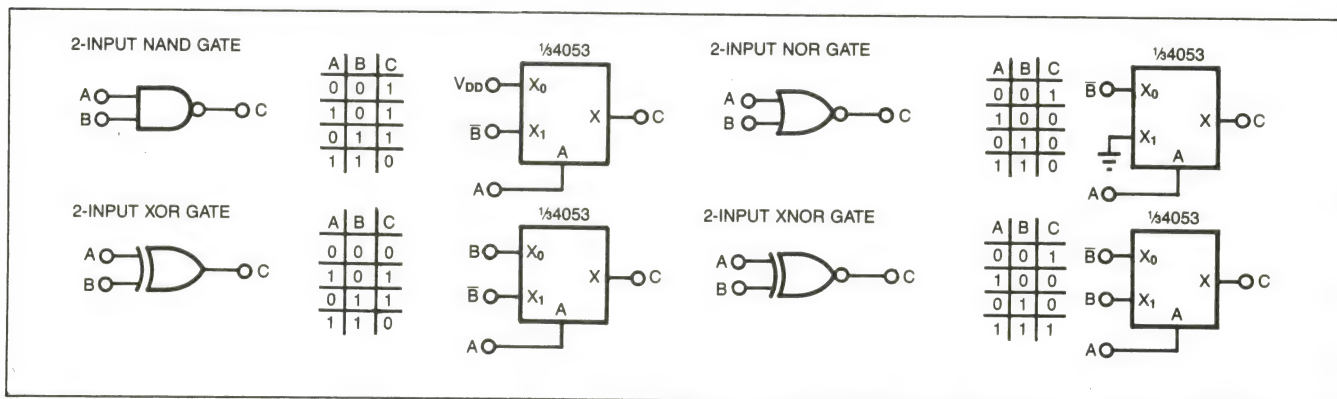


Fig 2—Each of these 2-input gates requires the complement of one input if you're going to use a 4053 to effect them.

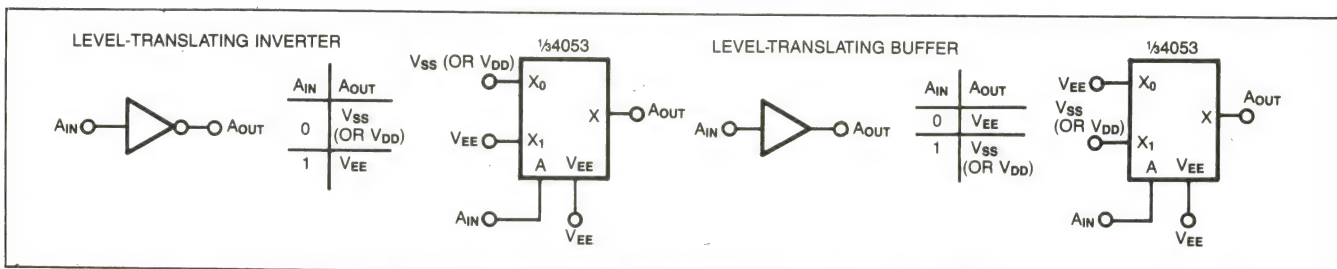


Fig 3—These circuits use a 4053 to translate positive logic levels to negative logic levels (using V_{SS}) and to bipolar logic levels (using V_{DD}).

Digital-delay circuit is programmable

Gary Embler

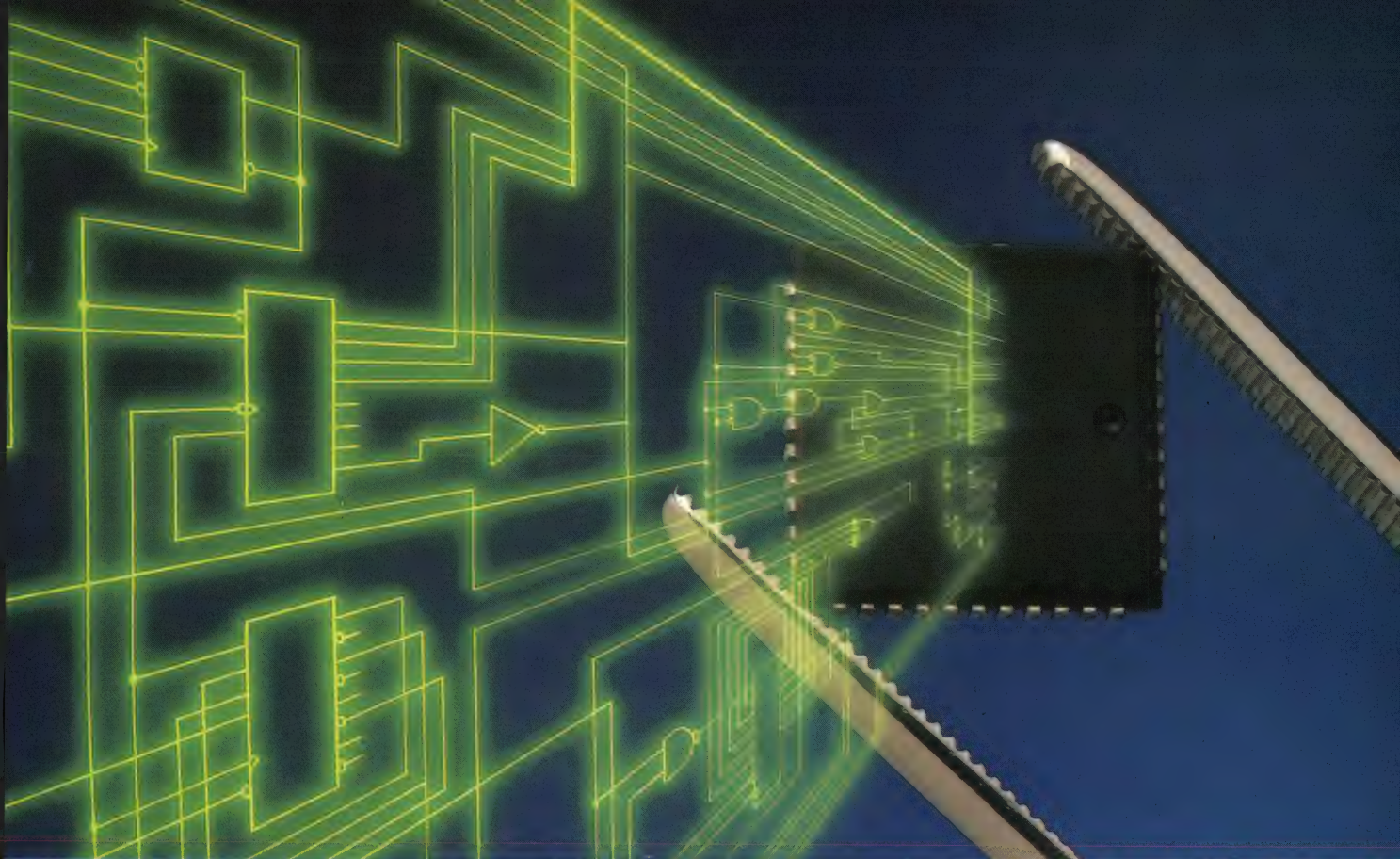
Tall Tree Systems, Palo Alto, CA

The circuit shown in Fig 1 lets you delay the positive digital transitions applied at the Start Input according to a programmable time interval. Within the available range, you can program a desired delay time to 16-bit accuracy.

The clock-synchronizer section synchronizes the main clock signal, $1 \times \text{Clock}$, with the Start Input signal. When the Start Input goes from a low to a high level, the divide-by-16 counter (IC_3) first resets to zero, then counts at the $16 \times \text{Clock}$ rate. In the counter section, two cascaded 8-bit counters, IC_7 and IC_8 , form a 16-bit

counter. Because each of these ICs contains an 8-bit parallel-input register, you can store the low and high bytes of the desired delay factor by applying data at D_0 - D_7 and strobing the appropriate Load input. The counters remain inactive as long as IC_{6B} 's Q output holds the counter's CLoad inputs high.

When a positive transition at the Start Input causes IC_{6B} 's Q output to go low, the 16-bit delay data passes internally from the registers to the counters. The counters immediately begin counting up from their preloaded values at the $1 \times \text{Clock}$ rate. The delayed positive-output transition occurs at pin 9 (RCO) when IC_8 's counter rolls over from 255 to 0. Finally, IC_{6B} 's Q output goes high, which returns IC_7 and IC_8 to the load



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CIRCLE NO 219

DATA I/O

DESIGN IDEAS

state to wait for the next positive transition at the Start Input.

Delay time, t_D , from the Start Input signal to the Delayed-Transition Output is

$$t_D = 16(65,535 - 256x - y)t_C + 18.5t_C \pm 0.5t_C,$$

where

x = the decimal value of the high-order delay byte ($0 \leq x \leq 255$)

y = the decimal value of the low-order delay byte ($0 \leq y \leq 255$)

t_C = the period of the 16× Clock signal.

To increase the maximum delay time, you can either slow down the 16× Clock (sacrificing accuracy) or add 74LS592 counters.

EDN

To Vote For This Design, Circle No 746

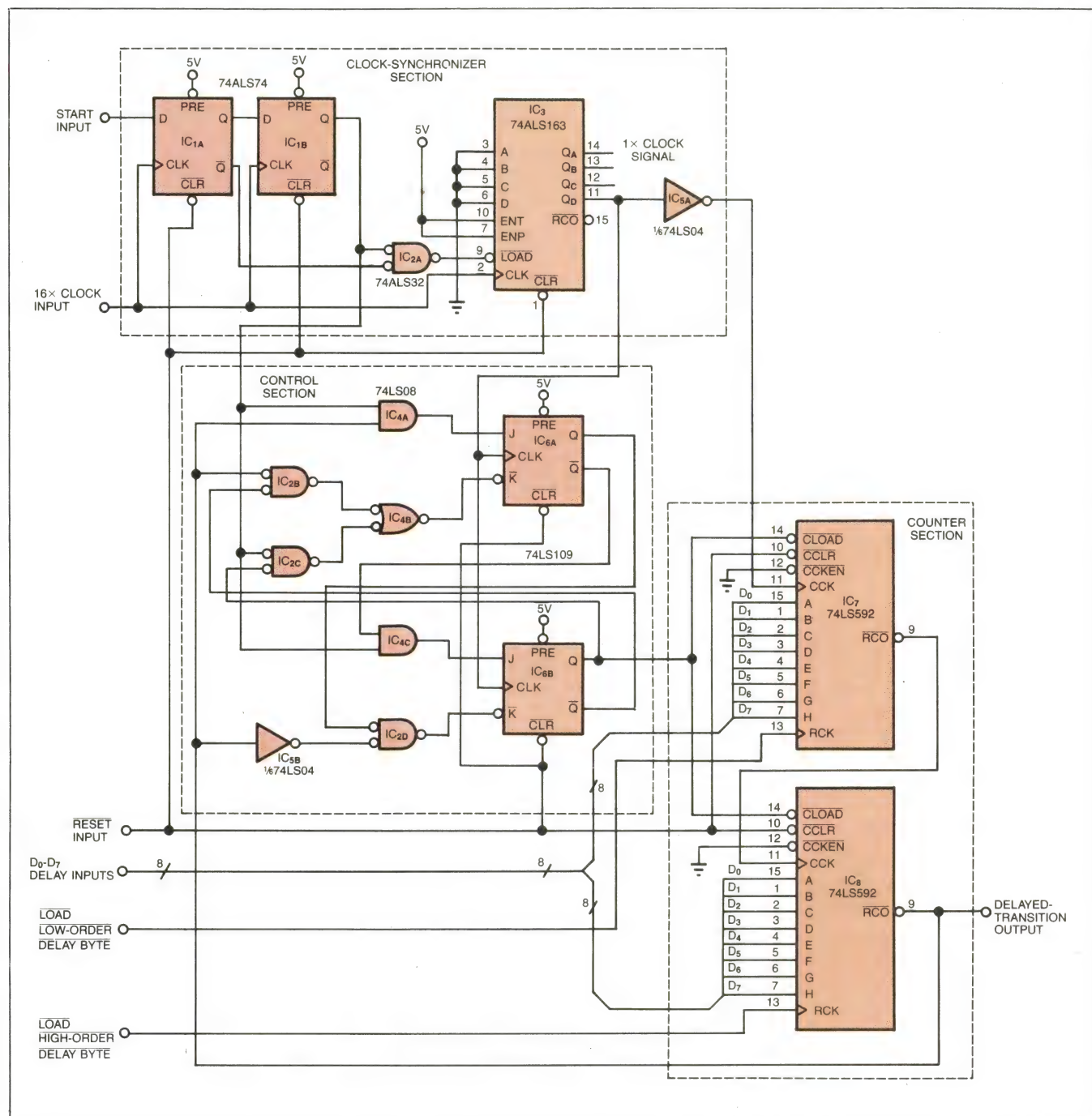


Fig 1—This circuit provides a programmable delay for positive transitions at the Start Input signal. You load the 16-bit delay factor in two consecutive bytes, from the D₀-D₇ inputs.

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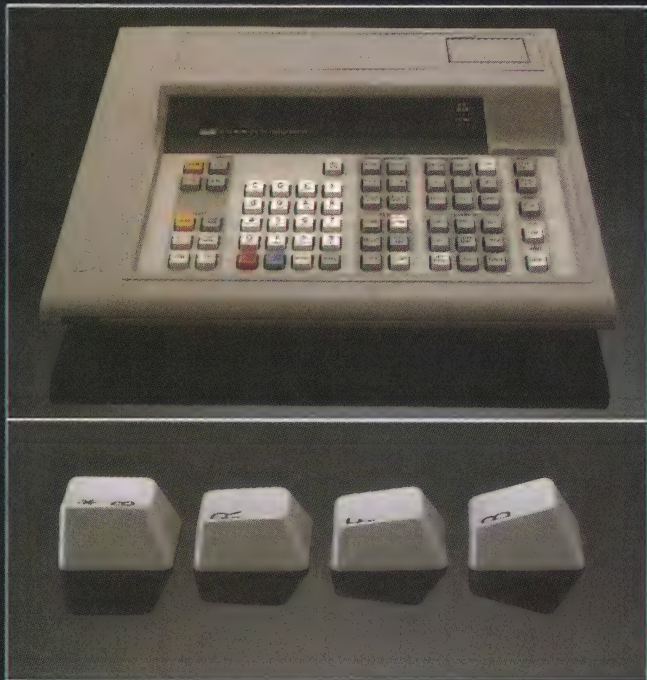
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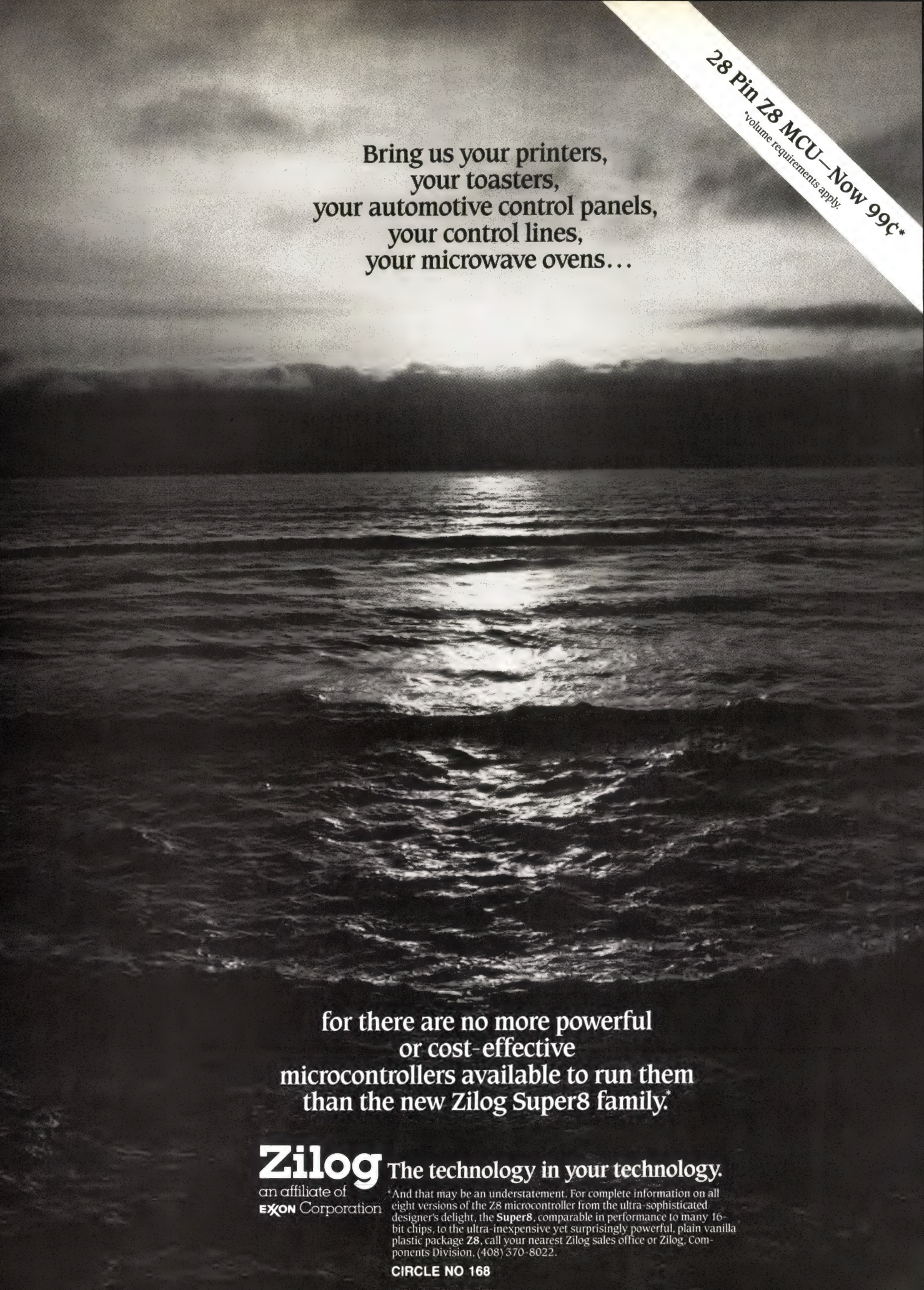
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NEW PRODUCTS

COMPUTER-AIDED ENGINEERING



DOCUMENT EDITOR

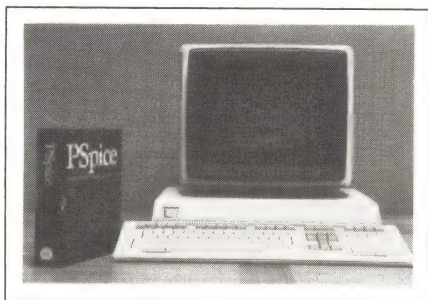
- Combines text and CAE/CAD graphics
- Runs on IBM PCs, MicroVAXs, and VAXs

The CT2200 document editor combines text and CAE/CAD graphics. This package enables you to produce documentation from a CAE/CAD database that includes flowcharts, schematic drawings, simulation results, and pc-board layouts. Using the software, you can define character fonts and scale drawings to fit in your documents. Pan and zoom capabilities let you scan your document. Because the editor uses an ACSII file format, you can use a text editor to work with graphical and textual files. The program interfaces to laser printers; output resolution specs 300×300 dots. The editor runs on IBM PCs and compatible computers (under PC- or MS-DOS), on DEC MicroVAXs and VAXs (under VMS), and on Sun

workstations. IBM PC version, \$2500; MicroVAX version, \$5000; VAX version, \$7500.

Case Technology Inc., 633 Menlo Ave, Menlo Park, CA 94025. Phone (415) 322-4057. TLX 506513.

Circle No 351



CIRCUIT SIMULATOR

- Runs Spice on members of the DEC VAX family
- Has the same input syntax and output as the PC-based version

PSpice, an analog electrical circuit simulator, now runs on members of the DEC VAX family, including the

MicroVAX II. The Device Equation option, the Probe graphics postprocessor, and the Parts parameter estimator also run on VAXs. Probe and Parts can display graphics on Tektronix 4014 terminals and on DEC's VT125 and VT200 terminals. The software can generate graphics for dot-matrix printers and pen plotters. The VAX-based versions use the same input and output syntax as the PC-based version. For VAX versions, PSpice, \$1900; Device Equations option, \$730; Probe, \$900; and Parts, \$900.

MicroSim Corp., 23175 La Cadena Dr, Laguna Hills, CA 92653. Phone (714) 770-3022.

Circle No 352

IC LAYOUT

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- Designs include gate arrays, standard cells

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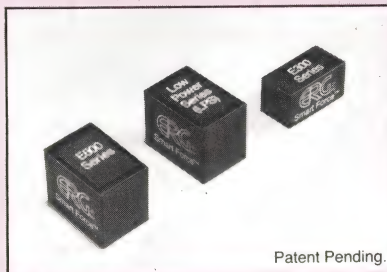


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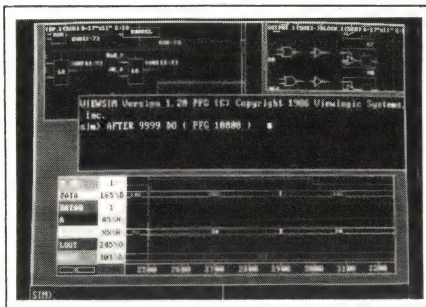
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CIRCLE NO 22

COMPUTER-AIDED ENGINEERING



CAE EDITOR

- Offers Ethernet communication between PCs and VAXs
- Simulation values appear on schematic

Workview version 2.0 offers Ethernet communication between IBM PCs and VAX/VMS computers. Other enhancements to the package include standard stroke fonts and a waveform processor that lets you enter data through a window. What's more, simulation values now appear on the circuit schematic. A macro record/execute feature allows you to execute strings of commands with a function key. A text editor lets you edit any ASCII data file from within the program. The software supports monochrome monitors that spec resolutions as fine as 1000×800 pixels. This release also includes PLD simulation. You can send output to Houston Instruments' plotters and Hewlett-Packard's Laserjet printers. All versions run on IBM PCs and compatible computers that contain 512k bytes of memory. \$4500 to \$13,000.

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Circle No 354

PC-BOARD CAD

- Captures schematics
- Places and routes boards

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Circle No 355

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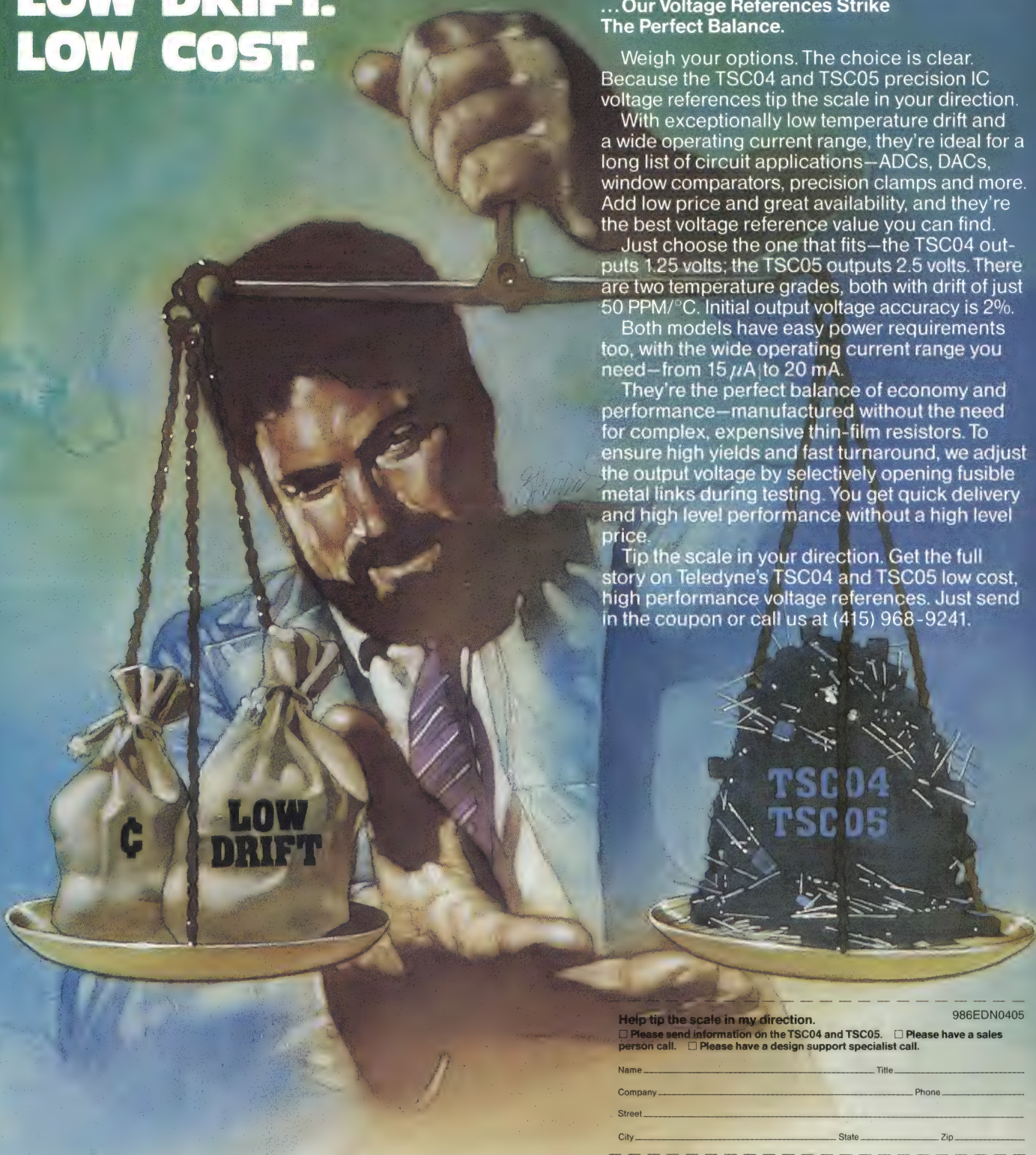
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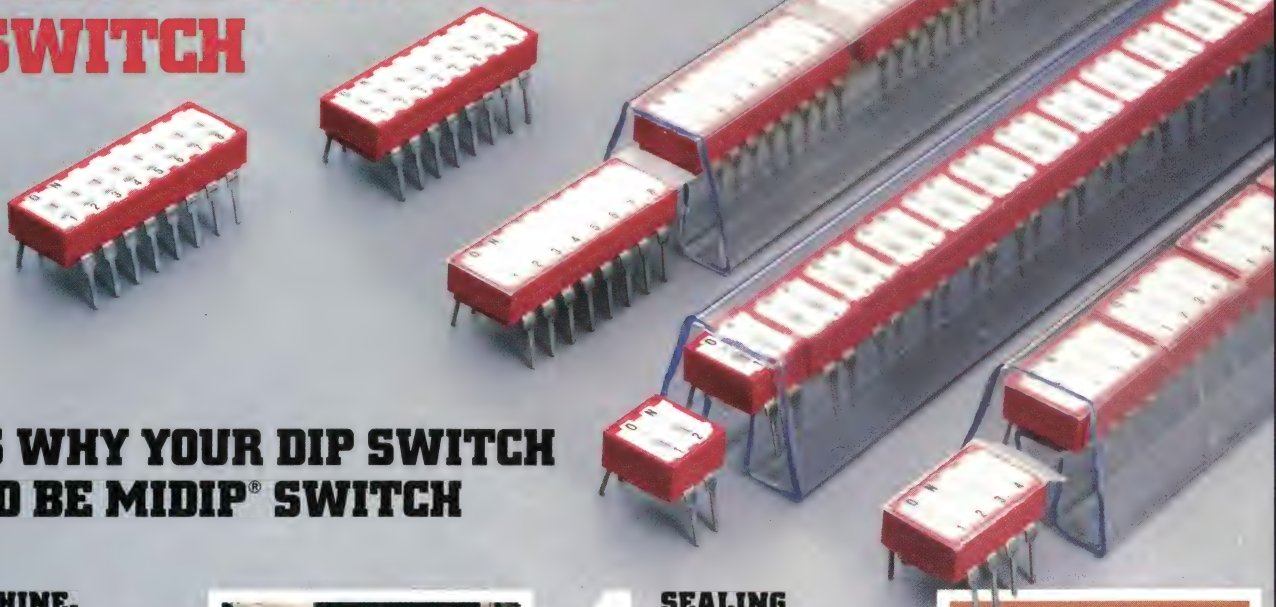
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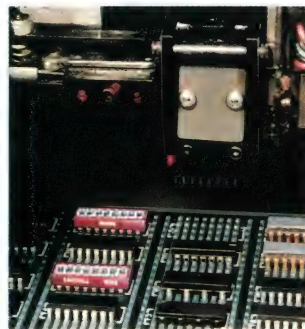
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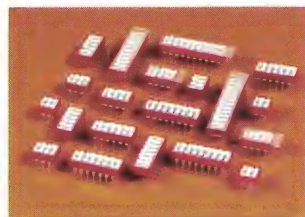
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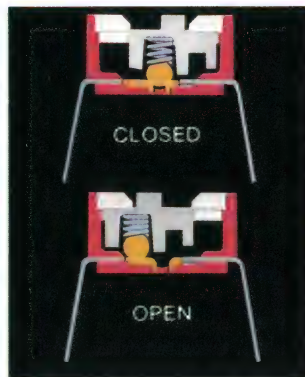
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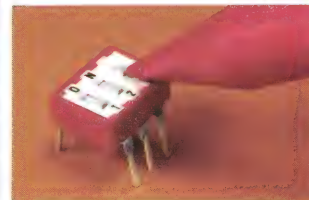
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Integral bottom seal provided by molded-in terminals. Optional top-surface seal provides maximum protection during solvent or high-pressure aqueous washes.



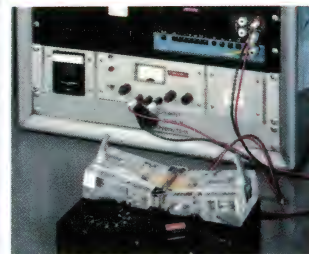
5 OPERATING CONVENIENCE

Easily activated with a pen or optional Grayhill "DIPSTICK."



6 QUALITY

Rated for 5,000 operations per position. Testing includes checking every contact on every switch, open and closed. 100% electrical inspection standard. Made of flame-retardant UL94V-0 plastics.



7 CONFIDENCE

Grayhill is a leader in DIP switches, with a reputation built on quality and service. The MIDIP switch is designed right—built right—and priced right—with the additional bonus of local availability through your authorized Grayhill distributor. Two reputations depend on your DIP switch choice!



Ask for detailed literature—including complete specifications and prices—and test samples. **CIRCLE NO 169**

Grayhill
INC

AVAILABLE LOCALLY THROUGH THESE REPRESENTATIVES

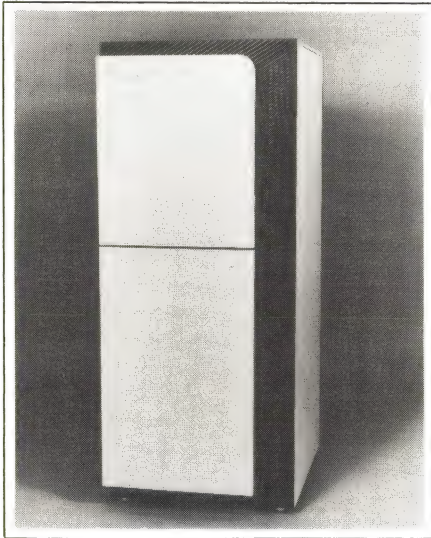
AUSTRALIA/NEW GUINEA Acme Engineering
Kilguth, Victoria • Tel: (03) 890-0900
BELGIUM/LUXEMBOURG Rodelco SA/NV Electronics
Brussels • Tel: 02-2166330
CHINA, REPUBLIC OF Morihan International
Taipei • Tel: (02) 752-2200
DENMARK E.V. Johansen Elektronik A-S
Copenhagen • Tel: (01) 83 90 22
FRANCE Radio Television Francaise
Gentilly • Tel: (014) 664.11.01

FINLAND Oy Flinkenberg & Co., AB
Helsinki • Tel: (90) 647-311
GERMANY Data Modul GmbH
München • Tel: (089) 56 01 70
HONG KONG Components Agent Ltd.
Hong Kong • Tel: (0) 4992688
INDIA Hindco Corporation
Bombay • Tel: (22) 493-1544
ISRAEL Rapac Electronics, Ltd.
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Milano • Tel: (02) 46 90 444
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Breda • Tel: (076) 784911
NEW ZEALAND S.D. Mandeno
Auckland • Tel: (09) 600-006

NORWAY Hans H. Schive A/S
Nesbru • Tel: (02) 84 51 60
SINGAPORE, REPUBLIC OF Microtronics Associates Ltd.
Singapore • Tel: 7481835
SOUTH AFRICA, REPUBLIC OF Liberty Electronics Ltd.
Boksburg • Tel: (11) 52-7637
SOUTH KOREA Unistandard Corporation
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Madrid • Tel: (01) 242 52 04

SWEDEN Bo Palmblad Aktiebolag
Bromma • Tel: (08) 25 27 20
SWITZERLAND Walter Blum AG
Zürich • Tel: (01) 411(1) 312 68 72
UNITED KINGDOM Highland Electronics, Ltd.
Burgess Hill, West Sussex • Tel: (044 46) 45021



that optimizes simulation operations. The package includes a parallel version of Lasar 6. The program assigns processors in response to the needs of multiple users and to varying simulation loads. Simulations run without slowing other Lasar functions, such as model compilation and test postprocessing. These functions run separately on general-purpose processors, which also handle system I/O, operating-system overhead, and network communications. The basic system includes Lasar 6, two general-purpose processors, four optimized simulation processors, 16M bytes of main memory, a 330M-byte storage disk, a tape drive, and 16 terminal

ports. \$300,000 to \$700,000.

Teradyne Inc., 321 Harrison Ave, Boston, MA 02118. Phone (617) 482-2700. TWX 710-321-1055.

Circle No 356

PATTERN GENERATION

- *For digital designs that use scan-path techniques*
- *Assures 100% testability of detectable faults*

The ATPG (automatic test pattern generation) package ensures 100% testability of detectable faults in digital designs that use a scan-path methodology. By combining fault simulation and a path-tracing algorithm, the package can produce test vectors that find stuck-at faults in a scannable design. The company's design system, which simulates as many as 250,000 gates at a speed of 5 million evaluations/sec, uses this software to generate test vectors automatically. Once the logic design is complete, you can add test-circuit logic—such as scan rings—using the test-pattern generation package. The software runs on Apollo workstations. \$45,000.

Aida Corp., 3375 Scott Blvd, Suite 340, Santa Clara, CA 95054. Phone (408) 748-8571.

Circle No 357

MICROWAVE CAE

- *Based on HP Vectra PC and 9000 Series 300 computers*
- *Runs Touchstone software*

These microwave-CAE workstations consist of the company's Vectra PC or 9000 Series 300 computers and software. The workstations can accept parameters that you measure with the company's vector-network analyzers (eg, the 8510 for microwave and the 8753A for RF). The software consists of Touchstone, a circuit-simulation and -optimization program; Touchstone Sr, which adds modeling capability; Touchstone Monte Carlo analysis, which translates estimated tolerance and performance into predictions of production yield; and Linecalc, which synthesizes and analyzes line widths and other physical dimensions for microstrip and strip-line designs. EEsof Inc (Westlake Village, CA) developed the software. Software and Vectra PC, \$21,000; software and 9000 Series 300 computer, \$27,000; network analyzer, from \$23,500. Delivery, eight weeks ARO.

Hewlett-Packard Co., 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 358

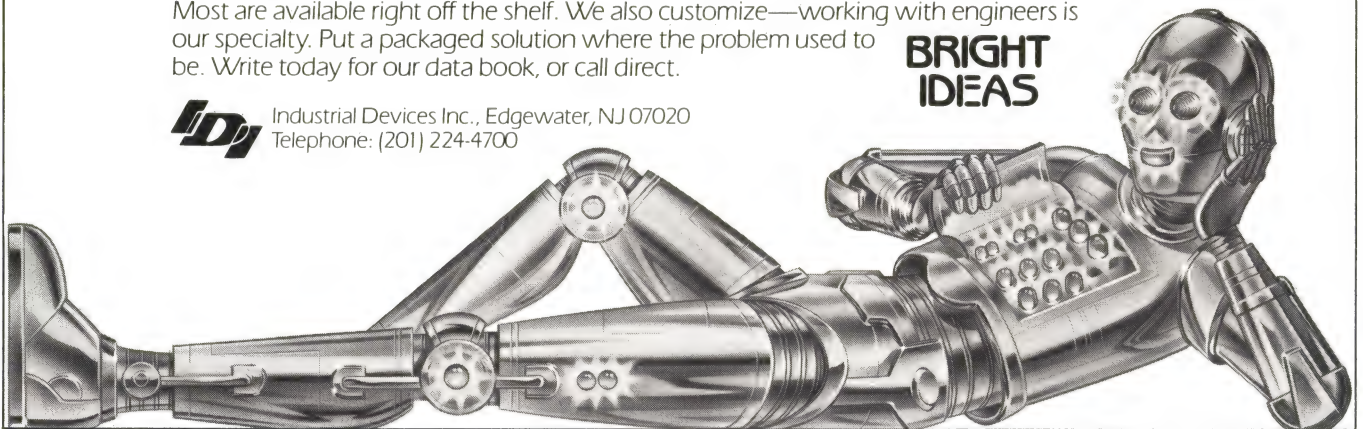
LED PACKAGING POWER

IDI's packaged LEDs solve more design problems—and cut assembly costs to bare minimums. Fast-mounting, space optimizing ideas for every PC board and panel need. Most are available right off the shelf. We also customize—working with engineers is our specialty. Put a packaged solution where the problem used to be. Write today for our data book, or call direct.



Industrial Devices Inc., Edgewater, NJ 07020
Telephone: (201) 224-4700

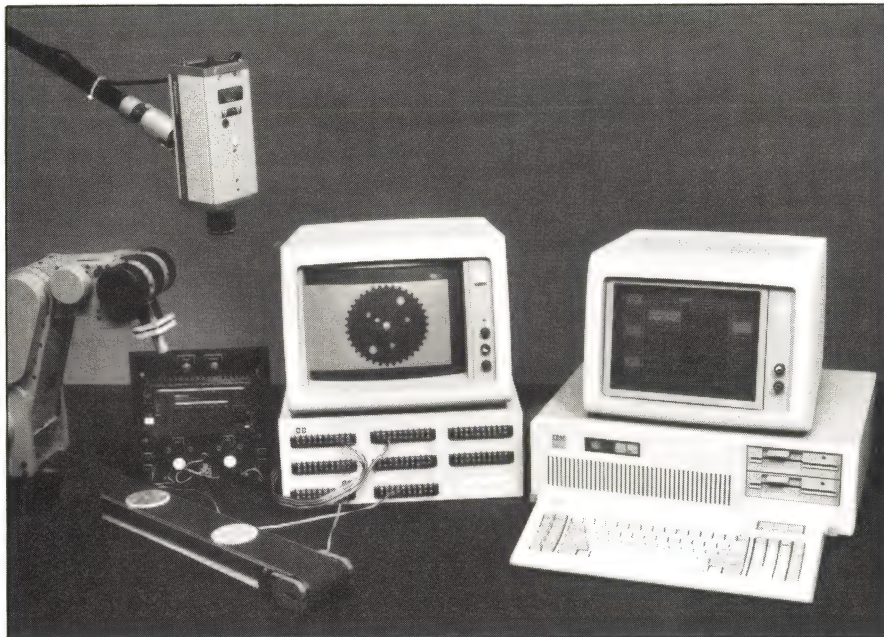
**BRIGHT
IDEAS**



CIRCLE NO 23

NEW PRODUCTS

COMPUTERS & PERIPHERALS



VISION SYSTEM

- Works with IBM PCs
- Can recognize and process 255 objects in single scene

Designed for use with an IBM PC, PC/XT, PC/AT, or compatible computer, the Viewflex vision system provides a hardware and software package that allows your computer to process visual data and recognize as many as 255 objects in a single scene. A control box included with the system has a frame digitizer and I/O ports suitable for an industrial

environment. The digitizer can address 64,000 pixels with 64 levels of gray scaling. System software includes a menu-driven application generator, suitable for use by non-technical personnel. You can use this system to control as many as four cameras. User-definable parameters include visual resolution, feature extraction, and system tolerances. \$6000.

Eshed Robotec Ltd, Box 28346, Tel Aviv 61282, Israel. Phone (03) 340860. TLX 361131.

Circle No 359

PARALLEL DRIVE

- 12.29M-byte/sec transfer rate
- Supports 1-, 4-, and 5-channel data transfers

The 689M-byte M2360A parallel transfer drive features a 12.29M-byte/sec transfer rate, an 18-msec head-positioning time, and 1-, 4-, or 5-channel data transfer. The unit uses a modified SMD interface for 4- and 5-channel parallel data transfers, and it lets you toggle between the two settings by switch. Through

software control, you can use the drive's serial data-transfer mode to send system data to and from the host processor. The drive is suitable for real-time image processing. You can connect as many as eight units in a star or daisy-chain configuration. All drives connected to the same controller will act as a single drive. \$19,000 (OEM qty).

Fujitsu America Inc, 3055 Orchard Dr, San Jose, CA 95134. Phone (408) 946-8777. TLX 176207.

Circle No 360

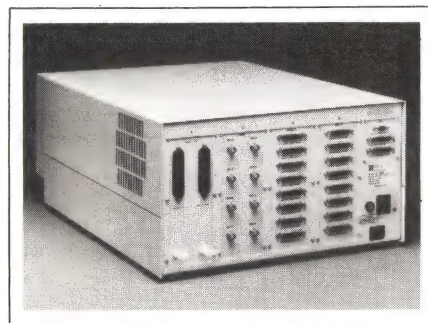
TOKEN-RING SERVER

- Links 64 terminals on token-ring LAN
- Uses an 802.5 Multibus network controller

Linking as many as 64 terminals, host computers, and other devices to a token-ring LAN, the CS/1-TR communications server uses an IEEE 802.5 Multibus token-ring network controller, based on the TMS380 VLSI token-ring chip set. The server supports any mix of as many as four I/O options, including I/O modules with eight or 16 RS-232C ports, eight 3270-compatible, coaxial, Type A ports, and bisynchronous and bit-synchronous RS-232C ports. In a 64-port configuration, servers can allow as many as 16,640 users to communicate on a single ring, based on a 260-node maximum per ring. The unit also lets you implement password security, broadcast messages among users, and select parameters for individual ports. Its network-management features include onboard collection and display of CPU and buffer utilization, traffic and errors at either the port or ring level, and provisions for call queuing and automatic flow control. The 64-port version, \$16,000; controller board, \$2000.

Bridge Communications Inc, 2081 Stierlin Rd, Mountain View, CA 94043. Phone (415) 969-4400. TLX 176544.

Circle No 361



PMI's 1986 ANALOG APPLICATIONS SEMINAR

Austria

Vienna, Oct. 6

Belgium

Brussels, Oct. 2

Denmark

Copenhagen, Oct. 3

Finland

Helsinki, Oct. 6

France

Paris, Sept. 25

Lyon, Oct. 10

Germany

Munich, Sept. 26

Dusseldorf, Oct. 9

Israel

Haifa, Sept. 29

Tel Aviv, Sept. 30

Italy

Milan, Oct. 8

Rome, Oct. 9

Netherlands

Utrecht, Oct. 1

Norway

Oslo, Oct. 8

Spain

Barcelona, Oct. 10

Sweden

Stockholm, Oct. 7

United Kingdom

London, Sept. 22

Manchester, Sept. 23

Edinburgh, Sept. 24

Yugoslavia

Ljubljana, Oct. 7

Japan

Tokyo, Nov. 5

Tokyo, Nov. 6

Osaka, Nov. 7

Korea

Seoul, Nov. 3

Seoul, Nov. 4

Singapore

Singapore, Oct. 27

Taiwan

Taipei, Oct. 29

Taipei, Oct. 30

FOR RESERVATIONS:

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PMI's all new 3-hour technical seminar is coming to a city near you this Fall. PMI presents over 25 bench-tested applications circuits showing new solutions to tough analog design problems.

Learn cost-effective ways to:

- Maximize linearity and bandwidth
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Know more about:

- High accuracy non-linear circuits
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Receive:

- Complete course notes
- New applications handbook
- Samples of latest high performance analog ICs

Precision Monolithics Inc.

A Bourns Company

Santa Clara, California, USA

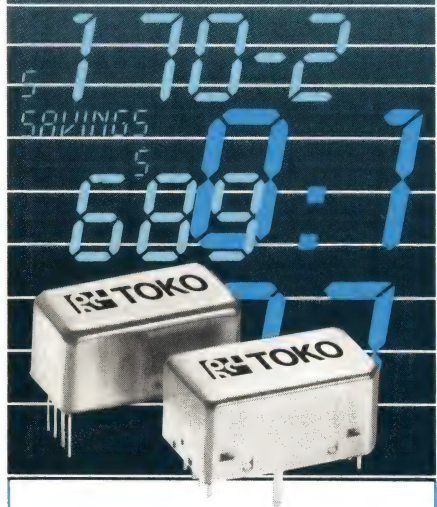
408-727-9222

FRANCE: 01-40 03 35 93; GERMANY: 0711-22 93 0; NETHERLANDS: 070-87 54 04; SWITZERLAND: 042-33 33 33;
UNITED KINGDOM: 01-572 65 31; HONG KONG: 0-4992688; JAPAN: (03) 234-1411; ARGENTINA: 46-5776/0628/0864/2214;
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The precision solution.

Toko DC-DC Converters: A Bright Idea for Powering Vacuum Fluorescent Displays.



Whether you're using Futaba, ISE or NEC vacuum fluorescent displays, Toko CPS series DC to DC Converters are the power solution to provide grid, anode and filament voltages—with high reliability and cost savings. They also provide stable power for modems, RS-232 interfaces and other subsystems requiring mixed operating voltages, at prices much lower than other power alternatives. Contact us to be sure you're not over specifying your DC to DC Converter needs.

High performance characteristics:

- ☐ Stable output levels for flicker-free displays
- ☐ High switching frequency and ceramic substrate design combined with SMT for high power and very compact size
- ☐ Full metallic shielding and matched external filtering prevents EMI problems
- ☐ Delivers rated performance from -20 to +65°C at 10 to 85% RH

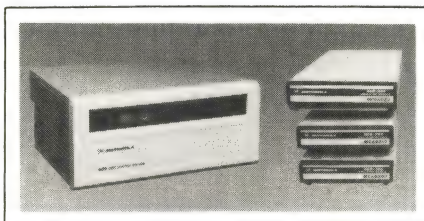
The CPS series is available in power outputs to 2.4 watts, with input voltages of 1.7 to 30 VDC and output voltages ± 5 to ± 50 VDC or 1 to 10 VRMS AC. For more details and application assistance, contact Toko America today.

TOKO
TOKO AMERICA, INC.

1250 Feehanville Drive
Mount Prospect, Illinois 60056
(312) 297-0070, TELEX: 724372
FAX (Gill): (312) 699-7864

CIRCLE NO 24

COMPUTERS & PERIPHERALS



20-MHz EMULATOR

- For HDS-300 development system
- Zero-wait-state emulation to 16 MHz

To help with the task of developing a 32-bit MC68020 μ P, you can now add the M68020HM3 emulation module to the HDS-300 development system. The module includes memory for real-time, zero-wait-state emulation at clock rates to 16 MHz (20 MHz with one wait state). It also provides cache-memory support and C language debugging at the source level. System-performance analysis is optional. The emulator operates with one of three host computers: an IBM PC with at least 10M bytes of disk capacity; a VME/10; or a VME System 1131. Three versions of the emulator offer 64k-, 256k-, and 1M-byte emulation RAMs. \$6500 to \$16,300; system-performance analyzer module, \$4500; HDS-300 control station, \$7195.

Motorola Semiconductor Products Inc., Box 20912, Phoenix, AZ 85036. Phone (602) 438-3501.

Circle No 362

COLOR MONITOR

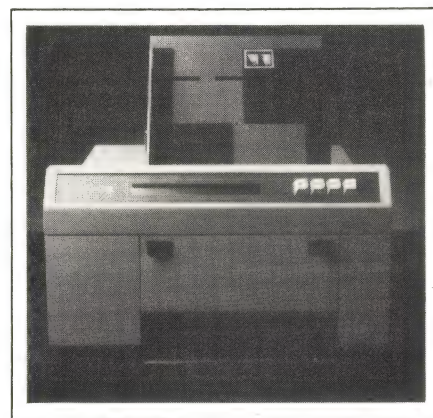
- Offers 1600 $\times$ 1280-pixel resolution
- 19-in. analog RGB monitor

Offering 1600 $\times$ 1280-pixel resolution, the MX-4190 19-in. analog RGB monitor has 60-Hz noninterlaced refresh, which provides a flicker-free image display. This raster-scan color display system offers nearly photographic quality displays for applications such as CAE, computer graphics, animation, and simulation. Its video bandwidth is greater than 160 MHz, and its

brightness ranges from 40 to 55 fL. Beam divergence is <0.1 mm within a centered 6-in. circle and <0.4 mm elsewhere on the screen's surface. Linearity is better than 1% over the entire visible display. Raster-size regulation is 0.5% overall and from 0 to 100% APL (average-picture level). For CAE applications, the monitor's high dimensional accuracy lets you take measurements directly from the screen. \$5995.

Monitronix Corp., 2971 Silver Dr., Columbus, OH 43224. Phone (614) 262-0334.

Circle No 363



DOCUMENT PROCESSOR

- Converts printed text or graphics as fast as 100 cps
- Features automatic 50-sheet feeder

The CDP compound document processor can convert printed text or graphics to computer data at a rate as high as 100 cps. The manufacturer claims that the CDP can read typeset or typewritten text in virtually any size, style, or format without human intervention or prior manual training of the system. The unit has an automatic document feeder that holds 50 sheets and adjusts for sheet sizes from 3 $\times$ 5 in. to 8 $\frac{1}{2}$ $\times$ 14 in. The processor can read boldface, italicized, and proportionally spaced characters in portrait or landscape mode. Using its standard RS-232C interface, the unit can download the data to your host computer or PC; you can order an op-

SIEMENS

Contacts you can rely on: **SBM 383 connectors**

Insulation displacement contacts
for flat cables

Shroud tin-plated
ensures correct mounting

Insulation displacement contacts
for round cables or discrete wires

Spring clips on pin connectors
ensure ground contact
between the pin-contact and receptacle connectors



Electronic development engineers expect high quality at low cost from modern connector systems. For this reason high demands are made of the various individual components.

With SBM 383 subminiature connectors Siemens offers a wide range of economically priced products.

● A variety of applications

Applications for SBM 383 connectors are found in telecommunications, text and data processing, as well as in test engineering and instrumentation and control. They are employed as rack and panel connectors, cable connectors and equipment connectors.

● A variety of termination styles

The connectors are available with terminals for soldering, wave-soldering (straight and angled), insulation displacement and crimping.

SBM 383 connectors are compatible with all commercially available SBM connection systems and comply with the latest IEC draft standard 48B (Germany) 99 at requirement levels 2 and 3. With polyester as the insulation material, good temperature stability is achieved.

Should you wish further information, please write to Siemens AG, Infoservice 143/085, Postfach 2348, D-8510 Fürth.

Electromechanical components from Siemens

When Choosing Quality The Choice Is LEMO Electronic Connectors



LEMO B Series quality connectors available in multicontact from 2 to 64 contacts, or unique coaxial-multicontact, or high voltage multicontact configurations

SPEED: Connectors engage and disengage simply and quickly by pushing and pulling axially with the mated connector.

SPACE SAVINGS: Only finger clearance on two sides needed to engage and disengage connectors. No need to twist or turn locking ring.

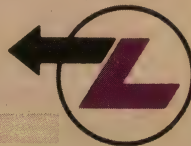
RELIABILITY: Key/Keyway pattern provides mating exclusivity. Quick-Lok mechanism assures secure contact by audible click when lock is engaged. Color coding is available too.

RUGGEDNESS: Connector components are precision machined from brass bar and tubing stock, plated with copper and then nickel. Locking mechanism is totally protected by outer shell, virtually eliminating accidental disconnections, damage to locking mechanism, cables and contacts.

AESTHETIC-FUNCTIONAL DESIGN: Outer shell and back nut finished with matte chrome plating. Contacts are gold plated. LEMO connectors will complement any front panel application.

Over \$1 million inventory stocked in Santa Rosa, California, sold by a network of representatives in North America.

For technical data and catalog, as well as the name of your local representative, please call or write LEMO U.S.A., INC. (707) 578-8811, P.O. Box 11006, Santa Rosa, California 95406.



LEMO USA INC

CIRCLE NO 170

See us at Midcon booth #1429 and at Northcon booth #1120

COMPUTERS & PERIPHERALS

tional Multibus or Ethernet interface. The processor also lets you generate such formatting functions as character flagging and spelling correction. \$39,500. Delivery, 60 days ARO.

Palantir Corp., 2500 Augustine Dr, Santa Clara, CA 95054. Phone (408) 986-8006.

Circle No 364



10-MHz COMPUTER

- Hardware- and software-compatible with IBM PC/AT
- 10- and 6-MHz modes

Offering a 25% improvement in speed over the 8-MHz IBM PC/AT, the pc-286 contains a 10-MHz μ P, but also provides a 6-MHz mode for full software compatibility with the slower, original version of the PC/AT. The basic unit has 1.2M bytes of memory, expandable to 81.2M bytes of disk storage. It's also hardware compatible with the PC/AT. Standard features include Microsoft MS-DOS 3.1, GW-Basic 3.1, a choice of keyboard layouts, 640k bytes of RAM, eight expansion slots, a real-time clock with battery backup, an RS-232C port, and a parallel port. You can configure a computer with a combination of 1.2M-byte, half-height floppy-disk drives; 20M-byte, half-height hard-disk drives; and 40M-byte full-height hard disk drives. \$2499 to \$4199.

Wyse Technology, 3571 N First St, San Jose, CA 95134. Phone (408) 433-1000. TLX 3719730.

Circle No 365



DEVELOPMENT SYSTEM

- Provides access to IBM PC-compatible device drivers
- Allows multiple real-time tasks to operate independently

The STD Multi-DOS development system is a real-time, multitasking

system that provides access to IBM PC-compatible device drivers and files. The development system uses an STD-8088 operating system with a 100- μ sec interrupt response and a VRTX kernel. Within this development system, multiple real-time tasks operate independently without concern for the system responsibilities associated with interleaved execution. The Multi-DOS system consists of an IBM PC-compatible host, 256k bytes of RAM, a card cage with power supply, cables, and documentation. The development package includes PC-DOS, Multi-DOS BIOS, VRTX, and a real-time debugger called Tracer. \$6000.

Ziatech Corp., 3433 Roberto Court, San Luis Obispo, CA 93401. Phone (805) 541-0488. TLX 4992316.

Circle No 366

Can you test DC power supplies to real world conditions?



You can if you or your test system has the new Behlman DCT Series AC Power Source. Why? Because the DCT's capacity can respond to demands for high peak repetitive currents and power factors down to zero. With its IEEE-488 interface the DCT can be programmed to simulate real world line faults such as dropouts, surges, long duration transients, frequency variations, and more. No variable transformer can respond to or duplicate these kinds of conditions.

The DCT Series can also initiate voltage turn on at any point in a cycle while

providing capability for peak repetitive currents of up to 4.5 times its rating. Find out more about Behlman's new DCT Series. Call collect or write today.

(805) 684-8311

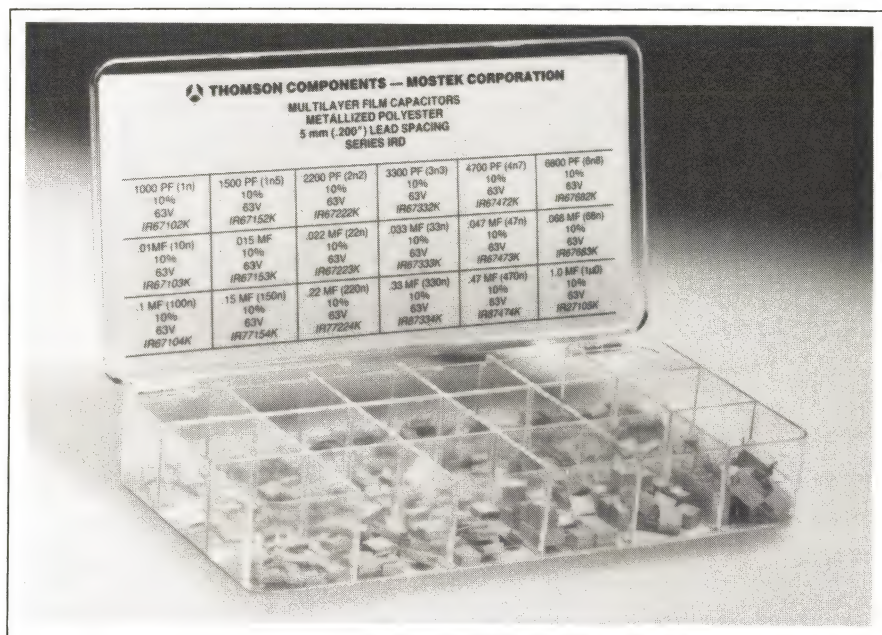
BEHLMAN
A Fiskars Company

1142 Mark Avenue
Carpinteria, CA 93013

CIRCLE NO 23

NEW PRODUCTS

COMPONENTS & PACKAGING



CAPACITOR KIT

- IRD multilayer film capacitors
- Contains 15 pieces each of 18 different values

Samples of this IRD multilayer-film capacitor kit are now available. These capacitors can be used in applications where X7R monolithics have been used traditionally. Kits include 15 pieces each of 18 different values, ranging from 1000 pF to 1 μ F. Capacitor cases have a 0.2-in. lead spacing with 10% tolerance and a 63V working voltage. \$35.

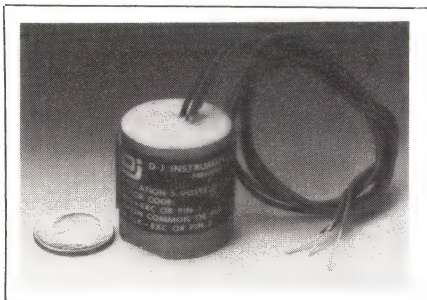
Thomson Components-Mostek Corp., 6203 Variel Ave, Unit A, Woodland Hills, CA 91367. Phone (818) 887-1010. TWX 310-371-9759.

Circle No 369

PRESSURE TRANSDUCER

- Features aluminum body
- Machined beam gauge

The MFP strain-gauge pressure transducer features a 1-piece aluminum body (stainless steel is optional) with a machined beam that features two semiconductor piezo-resistant gauges mounted in shear. It provides accuracy to 0.1% full scale for linearity, hysteresis, and repeatability. This half-bridge, 3-wire transducer performs more than 100M full cycles. Designed for OEM integration as a component in pc boards, the device is 1 1/4 in. long and 1 in. wide; it weighs 35g. Capable of withstanding 500g shocks on all axes, it's available in 25 to 10,000-psig full-scale ranges. You



can also specify various electrical and mechanical features. Less than \$50 (1000).

DJ Instruments Inc., 18 Republic Rd, North Billerica, MA 01862. Phone (617) 667-5301.

Circle No 367

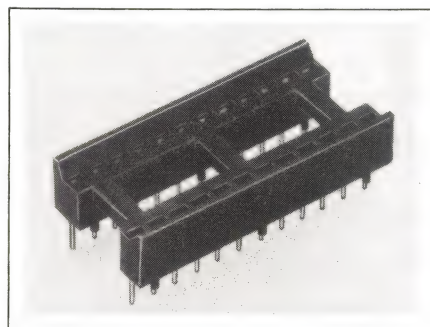
DIP SWITCH

- Can be inserted by a machine
- Features low contact resistance

The Series 90 Midip machine-insertable DIP switch maintains low contact resistance over its operating lifetime. The switch retains the company's spring-loaded sliding-ball contact; however, the ball now travels in a track, providing two points of contact to ensure low contact resistance. The top tape seal has passed seal tests, including the high-pressure aqueous cleaning process. This switch is available in versions with two through 12 stations. For an 8-station sealed switch, \$1.83 (100).

Grayhill Inc., Box 10373, La-Grange, IL 60525. Phone (312) 354-1040. TLX 6871375.

Circle No 368



MEMORY SOCKET

- Designed for TI and NEC 24-pin video RAMs
- Fits row spacings set on 0.4-in. centers

This 24-pin video RAM socket, the ICN Series, is designed for TI and NEC 24-pin video RAMs and fits row spacings set on 0.4-in. centers. The socket offers dual-wipe contacts, alignment ramps, and open frames. It is available with phosphor-bronze or beryllium-copper contacts and either tin or gold plating. \$0.485 (100).

Robinson Nugent Inc., 800 E Eighth St, New Albany, IN 47150. Phone (812) 945-0211.

Circle No 370

Without the right connections, you could pay a lot to deliver a little raster data.



There's no question that a raster processor is a wise investment. Without it, your computer is loaded down processing raster data for your hard copy devices. But unless you're careful, you could pay a fortune for a processor with more capacity than your plots demand.

That's why we designed our VP-10. For all but the densest plots, it's got all the processing power your hard copy devices need — at less than half the price of most high-volume processors.

The VP-10 will dramatically speed your plotting. Its pipelined architecture allows it to simultaneously receive input from your computer while it outputs data to the plotter. So communications between computer, terminal and plotter are lightning fast.

It's also versatile. Most popular hard copy devices are supported, including Benson, Calcomp and Versatec plotters, as well as the Seiko D-Scan thermal plotter, Matrix QCR camera and Minolta SP 50-B laser page printer. A variety of input options (such as *HPGL*, *Calcomp 906/907* and *KMW.PLT*) provide for easy connection to the host.

Best of all, the VP-10 has KMW's unmatched reputation behind it. We built the very *first* graphic element processor 10 years ago. And we've been innovating graphic processing solutions ever since.

So why pay for more raster processor than you need? Call KMW today at 1-800/531-5167 (in Texas, 512/836-8080) or write KMW Systems Corporation, 8307 Highway 71 West, Austin, Texas 78735.



**KMW
SYSTEMS
CORPORATION**

For the right connections

Auscom is now a division of KMW Systems Corporation.

Registered trademarks: Benson — Benson, Inc.; Calcomp — California Computer Products, Inc.; Versatec — Versatec, Inc.; Matrix QCR — Matrix Corp.; Minolta SP 50-B — Minolta Corp.; Seiko D-Scan — Seiko Instruments U.S.A.

VIDEO CONVERTER

- *Converts at 25 MHz*
- *Requires 13W*

Pin-compatible with the MOD1020, the ZAD1025 offers a conversion rate of 25 MHz, a fully variable conversion speed, a 13W power requirement, and a digitization of full-scale input signals to 12.5 MHz. The

device is ECL compatible and specs an S/N ratio greater than 56 dB. The architecture of this converter is the digitally corrected subranging type, which uses custom ICs and proprietary circuitry. It includes a 4-bit precision data encoder in conjunction with a 7-bit encoder to generate a 10-bit digital output word with a 1-bit overlap. The digital-

correction algorithm is implemented with a custom LSI circuit. \$2100 (100).

Analog Solutions, 940 Detroit Ave, Concord, CA 94518. Phone (415) 686-6660.

Circle No 371



**Opening
the door is not as
hard as you think.**

You've heard that surface-mount technology is complicated, mysterious, frightening, expensive to get underway . . . and absolutely essential if you're going to compete with the smaller, better performing, lower cost electronic products that are being designed today.

But, don't despair. Now there's a one-stop surface-mount technology center: Interplex Technologies. We'll eliminate the complication, mystery, fear and most of the start-up expense of SMT for you, quickly and cost-effectively.

Our product lines include standard and custom memory modules, interconnects for changing LCCs to leaded chip carriers to eliminate TCE, and complete Type I, II, and III SMT assemblies. In addition, we offer comprehensive design, prototyping, and testing services, plus

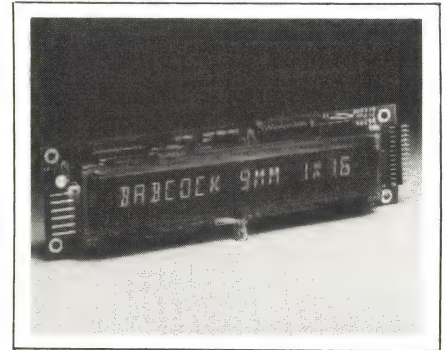
the capability to supply small, medium, and large production quantities. When you're ready for in-house manufacturing, we'll assist you in developing the most efficient systems and even provide specialized automated assembly equipment, if you need it.

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Contact Walter Bailey, Interplex Technologies Corporation, 381 Park Street, Hackensack, New Jersey 07602; 201/343-3156.

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CIRCLE NO 26



DISPLAY MODULE

- *Consumes 600 mA at 5V dc*
- *Mounted on one pc board*

Featuring a 1-line×16-character configuration, the VS-0116-01 vacuum-fluorescent display is mounted on a single pc board and includes the display, μ P controller, dc/dc converter, and drive electronics. It accepts both serial and parallel data. Brightness of the 9-mm characters is 175 fL; software dimming is standard. The display is blue-green and can be filtered to many colors. Viewing angle is a 150° conical. Power consumption is 600 mA at 5V dc. The display uses a 14-segment font that displays the 64-character ASCII set of upper-case letters, numbers, and symbols. \$76 (OEM qty). Delivery, six to 12 weeks ARO.

Babcock Display Products Inc., 1051 S East St, Anaheim, CA 92805. Phone (714) 491-5100. TLX 325133.

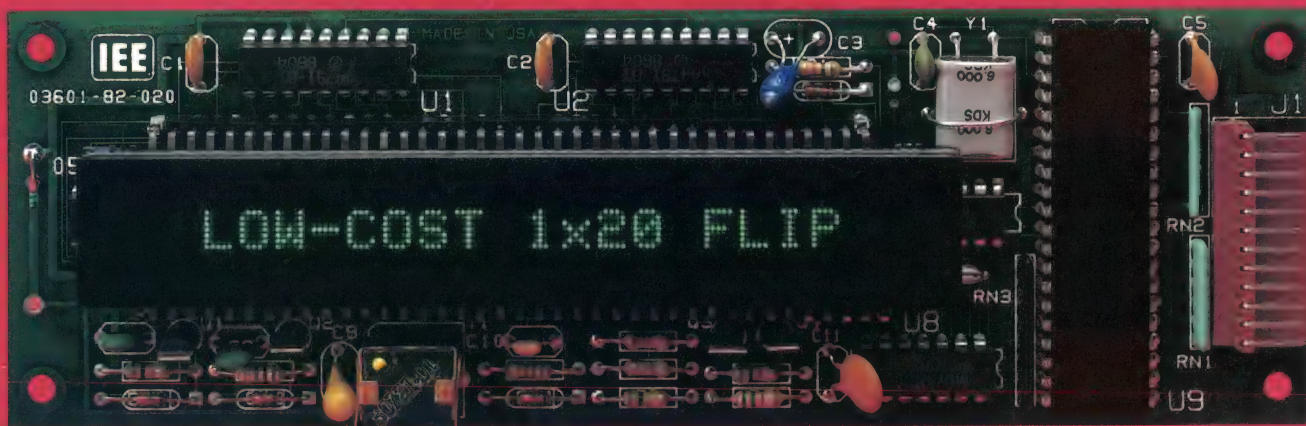
Circle No 372

SAMPLE/HOLD AMPS

- *6- μ sec access time max*
- *Incorporates a hold capacitor*

The SHC76 14-bit hybrid S/H circuits feature an acquisition time of 6 μ sec max. Aperture uncertainty is

THE \$64 ANSWER



ACTUAL SIZE

Now you can have a good-looking VF display at an **affordable price** with IEE's new line of "NO-FRILLS" FLIP™ vacuum fluorescent display modules.

These compact, economical displays share many of the most convenient features of the standard IEE FLIP display line, but at a much lower cost. The 1 x 20 model shown above is priced at only **\$64 each in quantities of 100**. Production-quantity pricing is even lower.

"NO-FRILLS" FLIPs are ideal for high-volume OEM applications such as copiers, point-of-sale terminals, pay telephones, and security systems.

And, just look at all of the features:

- Bright, easy-to-read 5 x 7 dot matrix characters
- On-board microprocessor that accepts parallel ASCII data
- Operation from a single +5VDC power supply
- Choice of several formats, including 1 x 20, 1 x 32, 1 x 40, 2 x 20, and coming soon—2 x 40

So, if you want a low-cost, high-quality front-panel performer, just call IEE and ask the \$64 question.



40th Anniversary

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Industrial Products Division
7740 Lemona Ave., Van Nuys, CA 91409-9234
Tel.: (818) 787-0311, Ext. 418 • Telex: 4720693 IEE IPD
FAX (818) 902-3723 (G2/G3)

<400 psec typ; droop is specified at $1 \mu\text{V}/\mu\text{sec}$ max. Offset voltage is $\pm 3 \text{ mV}$ max, adjustable to 0. The amplifier comes with a hold capacitor and incorporates an internal compensation network to minimize S/H charge offset. It is configured as a unity-gain inverting amplifier. The device comes in a 14-pin hermetically sealed metal DIP. Power supply requirements are specified from ± 14.5 to $\pm 15.5 \text{ V}$, with guaranteed operation from ± 11.4 to $\pm 18 \text{ V}$. Input-voltage range is $\pm 10 \text{ V}$. Two temperature ranges are available: 0 to 70°C (SHC76KM) and -25 to $+85^\circ\text{C}$ (SHC76BM). From \$52 (100).

Burr-Brown, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TWX 910-952-1111.

Circle No 373

TRIMMER CAPACITORS

- Q is >3000 at 250 MHz for 4.5-pF devices
- 500 V dc operating voltage

The small sapphire trimmer capacitors that make up the P Line spec a $0 \pm 50\text{-ppm}/^\circ\text{C}$ temperature coefficient. The line's 4.5-pF devices have a Q of over 3000 at 250 MHz and a 0.25-nH inductance at frequencies to 10 GHz . They feature an internal O-ring, are interchangeable with



unsealed designs, and have a 500 V dc operating voltage. Operating within the military temperature range, these capacitors withstand mechanical shock of 100g for 6 msec and vibrations of 60g at 10 to 2000 Hz . They comply with all MIL-C-14409D specifications. No flux or cleaning fluid can get inside, according to the manufacturer. Three models— 2.5-pF , 4.5-pF , and 8-pF versions—are available in 0.125-in. diameters. A 1.2-pF max version has a 0.075-in. diameter. Sample kit, with a combination of 15 parts, \$75.

Voltronics Corp., Box 476, East Hanover, NJ 07936. Phone (201) 887-1517. TWX 710-986-8253.

Circle No 374

PRESSURE SENSORS

- Absolute-, differential-, and gauge-pressure devices
- 0 to 1 through 0 to 100 psi

The SCX Series pressure sensors measure absolute, differential, and gauge pressure with ranges from 0 to 1 through 0 to 100 psi . Accurate reading for applications involving pressures as low as 0 to 5 in. of water column are guaranteed. When operating with a 12 V supply, the standard devices provide a zero-pressure offset of $300 \mu\text{V}$ max with an offset shift over temperature (0 to 70°C) of $100 \mu\text{V}$; full-scale span trimmed within a maximum tolerance of $\pm 1\%$; and a guaranteed span change over the temperature range of $< \pm 1.0\%$. Because the initial accuracy is laser trimmed, it allows these devices to be used in many applications without the need for any circuit adjustments or further external-temperature compensation circuitry. In addition, the sensors' $4\text{-k}\Omega$ impedance offers the low power dissipation required in most portable and battery-operated equipment. The output voltage is ratiometric to the supply voltage; full-scale outputs range from 18 to 100 mV . The devices can operate satisfactorily with supply voltages to 30 V . Accuracy is $> 0.1\%$ full-scale



NEW FROM LOGICAL DEVICES INC:

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A stand-alone programmer starting at \$895.00 can put you in business to program EE/EPROMs PAL/PLDs,* Single Chip micros,* and Bipolar PROMs,* + EPROM IN-CIRCUIT EMULATION* capability that can speed up your development time considerably and an RS-232 communications port that lets you integrate it with your IBM PC as a total firmware and Logic development station.

All from a company with an excellent reputation for quality and service.

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COMPONENTS & PACKAGING

output typ. From \$15 (100); evaluation kit, \$50.

Sensym Inc., 1255 Reamwood Ave, Sunnyvale, CA 94089. Phone (408) 744-1500.

Circle No 375

applications. Versions are available for ac or dc line power. Temperature models include reference-junction compensation of 0.03°C/°C. All models feature common packaging and screw terminal-block connections. A 5V dc-powered, dc-voltage-input version, \$89.

Doric Scientific, 3883 Ruffin Rd, San Diego, CA 92123. Phone (800) 854-2708; in CA, (800) 227-9781. TLX 249031.

Circle No 376

FSK RECEIVER

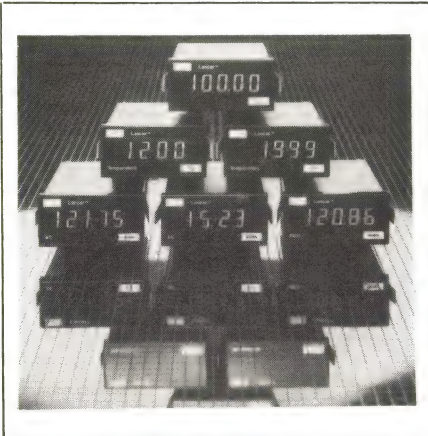
- Produces a zero-IF system
- Output data rate is 4000 bps max

The SM450 is a low-power radio receiver for direct FSK data-transmission systems. In this zero-IF system, VHF frequencies are converted directly to the audio frequency range. The direct-conversion approach, in which the local oscillator runs at the carrier frequency, converts VHF to FSK deviation frequency. No IF tuning and crystal or ceramic filters are necessary. A minimum of coils is required. Supply voltage ranges from 1.8 to 6V. Power consumption is 3 mA at 5V. Input sensitivity is 0.5 µV. The output data rate is 4000 bps max for 4.5-kHz FSK frequency

deviation. \$40 (1000).

Siltronics Ltd., 436 Hazeldean Rd, Kanata, Ontario, Canada K2L 1T9. Phone (613) 836-5000. TLX 0533936.

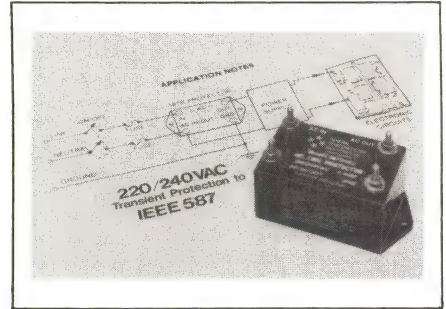
Circle No 377



PANEL METERS

- Feature DIN compatibility
- Offer choice of inputs

The 60 Series digital panel meters are DIN compatible. The line consists of 3½- and 4½-digit models with a choice of inputs that include various thermocouple types, dc or ac volts or amps, and volts or amps rms. Input ranges from millivolt levels to 600V; from microampere levels to 5A, and from -328 to 1999°F allow use in a variety of

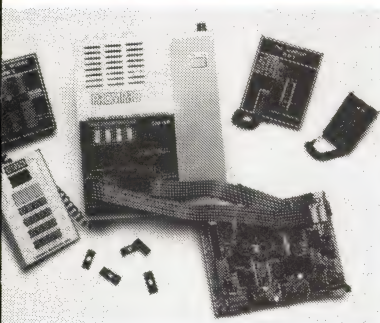


SUPPRESSORS

- Protect 220/240V ac-power equipment from transients
- Differential mode voltages <750V (worst case)

The Series 587B ac-power transient suppressors are designed to protect 220/240V ac equipment and meet the line-surge standards of IEEE-STD 587, Categories A and B. Intended to be hard-wired into the equipment between the power switch and the power supply, the models use solid-state Transzorb technology, which guarantees that differential mode voltages will not exceed 750V under worst-case con-

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	(02) 736-1564	790 82635

*some devices require optional adaptors.

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COMPONENTS & PACKAGING

ditions. Case operating-temperature range is -40 to $+85^{\circ}\text{C}$; current leakage at the 220/240V ac operating voltage is 1 mA (differential mode) and 0.5 mA (common mode). 587B062, \$65; 587B162, \$73 (100). Delivery, stock to six weeks ARO.

General Semiconductor Industries Inc., Box 3078, Tempe, AZ 85281. Phone (602) 968-3101. TWX 910-950-1942.

Circle No 378

F-O ATTENUATOR

- Offers calibrations between 850 and 1300 nm
- Insertion loss is <2.5 dB

Designed for multimode applications, Model 210 maintains a ± 0.5 -dB calibration accuracy over a 10- to 40-dB range. You can select calibrations between 850 and 1300 nm. You can vary attenuation continuously from the insertion loss to

beyond 50 dB. Insertion loss is <2.5 dB. The attenuator's LCD shows a 0.1-dB direct reading. The device has two display modes: The absolute mode displays the total attenuation level selected; the relative mode displays the difference between a set level and the actual attenuation. An internal lithium battery specs a lifetime of 10 years typ. The operating range is 0 to 40°C . The unit measures $10 \times 10.25 \times 3.75$ in. and weighs less than 6 lbs. \$2500.

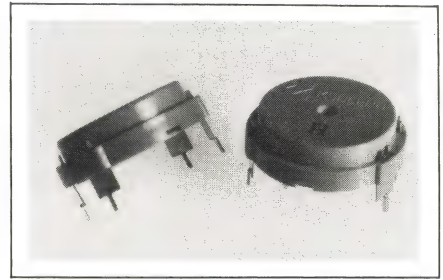
Intelco Corp., 8 Craig Rd, Acton, MA 01720. Phone (617) 264-4485.

Circle No 379

TRANSDUCER

- Dual resonant frequency near 1000 Hz
- Resonant impedance of 3500Ω max

The KBT-33SB-2T piezoelectric transducer has a dual resonant fre-



quency near 1000 Hz and a resonant impedance of 3500Ω max. It generates distinctive low tones when sound is warbled between frequencies. The transducer features four pins for mounting. The device operates without inductive coils. The sound-pressure level is 70 dB min (1 to 1.5 kHz, 30 cm). The input voltage is 20V p-p. \$0.58 (10,000). Delivery, eight to 10 weeks ARO.

Kyocera Northwest Inc., Electronic Components Group, 11425 Sorrento Valley Rd, San Diego, CA 92121. Phone (619) 454-1800.

Circle No 380



ARIES
ELECTRONICS, INC.

P.O. Box 130
Frenchtown, NJ 08825
Telephone (201) 996-6841
Telex 6974615
FAX 201-996-3891

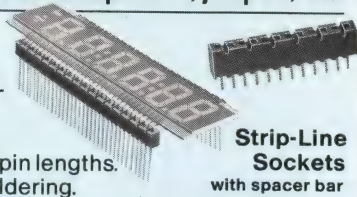
Headers, Sockets, Jumpers, DIP Switches, .025 Sq. Stix, etc.

SINGLE ROW SOCKETS with STAMPED PINS

For mounting odd centered components, jumpers, etc.

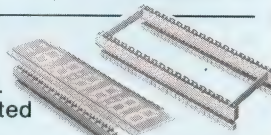
STRIP-LINE SERIES 0511

- Pins on .100 centers - bifurcated contacts.
- 2 to 34 positions.
- Solder tail or wire wrap pin lengths.
- Spacer bars for pre-soldering.



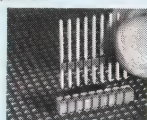
ELEVATOR STRIP-LINE SERIES 7XXX

- Height range from .350 to 1.25.
- Pins on .100 centers - bifurcated contacts.
- 2 to 34 positions.
- Spacer bars for pre-soldering.



LO-PRO® file STRIP-LINE SERIES 0520 and 0525

- Single beam contacts on .100 centers.
- 40 positions/strip (breakable to any desired number of positions, lose one pin on breaking.)
- Series 0520 accepts pins .008 to .020
- Series 0525 accepts .025 square pins.



See EEM Vol. C, pgs. 1185-1190

Series 0525
Accepts .025 square pins.

CIRCLE NO 30

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CIRCLE NO 31

The INMOS 256K CMOS DRAM. Feel the exhilaration of unparalleled speed.

INMOS sets performance standards again with the new IMS2800 family of second generation 256Kx1 DRAMS. It's upwardly compatible with 64K x 1 and first generation 256K devices.

With RAS access times of 60 to 150ns and cycle times down to 121ns, the IMS2800 family maximizes the speed-power benefits of CMOS without compromising traditional DRAM system costs.

INMOS continues to lead with an address multiplexing scheme that eliminates timing constraints while reducing speed loss associated with traditional DRAM designs. INMOS' unique 2ns Row Address hold time saves 10 to 15ns in the address multiplexing sequence. This, in addition to Static Column mode accessing, allows no wait state operation with the new generation of fast 32 bit microprocessors including Motorola's 68020, Intel's 80386 and our own T414 Transputer.

The IMS2800 from INMOS. Experience the speed for yourself.

Part Number	Function	Address Access Time (Max.)	RAS Access Time (Max.)	RAS Read/Write Cycle Time (Min.)
IMS2800-60*	Static	32ns	60ns	121ns
IMS2800-80	Column	43ns	80ns	146ns
IMS2800-10	Decode	53ns	100ns	176ns

Part Number	Function	Column Access Time (Max.)	CAS Access Time (Max.)	Page Mode Cycle Time (Min.)
IMS2801-60*	Enhanced Page Mode	32ns	11ns	35ns
IMS2801-80		43ns	13ns	46ns
IMS2801-10		53ns	16ns	56ns

Data on Nibble Mode and Extended Serial Mode versions available upon request.

*Contact factory for delivery.

INMOS, Colorado Springs,
Colorado, Tel. (303) 630-4000
Bristol, England,
Tel. 0272-290-861
Paris, France,
Tel. (1) 4 687-2201
Munich, Germany,
Tel. (089) 319-1028.

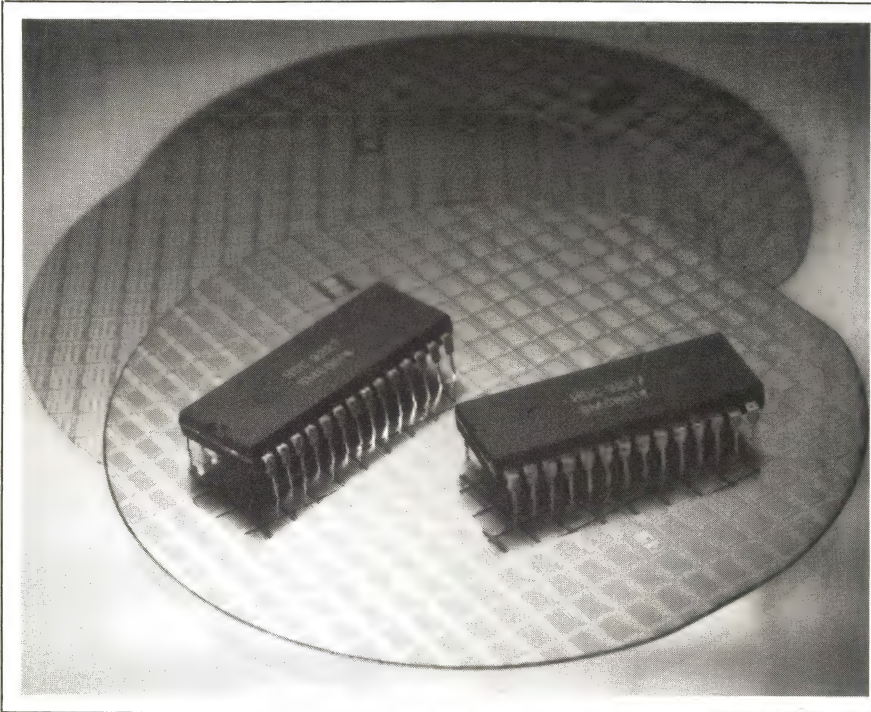


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NEW PRODUCTS

ICs & SEMICONDUCTORS



DATA SEPARATOR

- 20-bit cell-divide algorithm
- Hard-disk write-precompensation logic

The HDC-9227 universal-disk data separator is a recent addition to the HDC9224 disk-controller family. Combined with the manufacturer's HDC9223 analog support chip, the device provides all the digital functions needed to control an analog hard-disk data separator plus a high-resolution digital floppy-disk data separator. The device provides data separation for hard-disk drives

and IBM-compatible 8-, 5¼-, and 3½-in. floppy-disk drives. It features a 20-bit cell-divide algorithm for floppy-disk data separation and built-in hard-disk write-precompensation logic. The device's self-adjusting phase-locked loop eliminates the need for the tuning and tweaking required by analog data separators. 28-pin plastic DIP, < \$25(100). Delivery, six to eight weeks ARO.

Standard Microsystems Corp., 35 Marcus Blvd, Hauppauge, NY 11788. Phone (516) 273-3100. TWX 510-227-8898.

Circle No 386

OP AMPS

- Additions to the VA700 series
- Unity-gain stable

The VA705, -706, -707, and -708 are additions to the manufacturer's VA700 Series of high-performance monolithic operational amplifiers. The VA705 features an open-loop voltage gain of 20,000, a settling time of 250 nsec to $\pm 0.1\%$, and a

slew rate of 35V/ μ sec. The -706 features an open-loop gain of 5000, a slew rate of 40V/ μ sec, and a bandwidth of 40 MHz. Both devices are unity-gain stable and are internally compensated to drive capacitive loads as high as 500 pF. Each one delivers a 100-mA p-p output current. The -707 provides the same performance as the -705 and -706 but is stable in circuits with gains

≥ 10 . It features a slew rate of 135V/ μ sec and a 500-MHz gain-bandwidth product. The -708 features an open-loop gain of 5000, a 100V/ μ sec slew rate, and 150-nsec settling time to $\pm 0.1\%$. In 8-pin TO-99, 8-pin ceramic DIP, 8-pin plastic and SOIC (small-outline IC) plastic packages, from \$2.31 (1000).

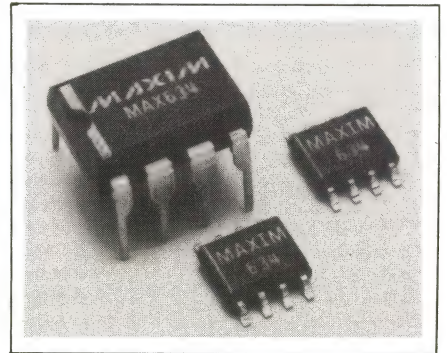
VTC Inc., 2401 E 86th St, Bloomington, MN 55420. Phone (612) 851-5000.

Circle No 387

REGULATORS

- Input-voltage ranges of 2 to 16.5V, 4 to 16.5V
- Free-running oscillator

The MAX634 and MAX4391 are low-power CMOS dc/dc inverting converter/regulators. The devices

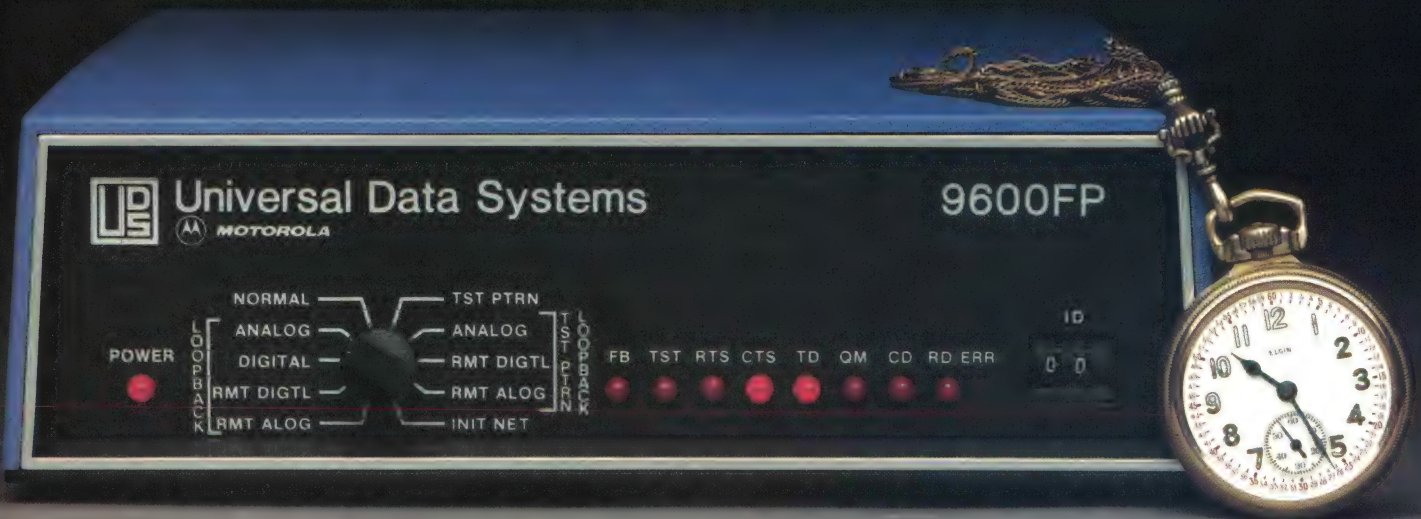


operate over an input-voltage range of 2 to 16.5V (MAX634) and 4 to 16.5V (MAX4391). The output voltage can be as high as -20V as long as the I/O voltage differential does not exceed 24V. The devices have a free-running oscillator set by an external capacitor. The oscillator provides the drive for an on-chip power MOSFET, which has an on-resistance of 4 Ω and a current rating of 375 mA max. In 8-pin plastic DIPs, MAX4391, \$2.71; MAX634, \$2.90 (100).

Maxim Integrated Products, 510 N Pastoria Ave, Sunnyvale, CA 94086. Phone (408) 737-7600.

Circle No 388

The triumph of technology over time



UDS 9600 Fastpoll cuts on-line training time 33%

Training time — it's probably the biggest deterrent to truly efficient throughput on any high-speed, dedicated data link.

The UDS 9600FP has cut on-line training time to 8 milliseconds, which is a 33% reduction of the previous 12 ms "industry standard." The result is a marked improvement in productive throughput and data link cost-effectiveness.

The device operates over unconditioned four-wire leased lines. In addition to its fastpoll capabilities, it can also function in the conventional CCITT V.29 mode. Integral test features allow for system performance evaluation and fault isolation within the communications link.

By incorporating LSI and microprocessor technologies, the UDS design also achieves size and power consumption advantages. For detailed specifications, contact Universal Data Systems, 5000 Bradford Drive, Huntsville, AL 35805. Phone **205/721-8000**; Telex 752602 UDS HTV.

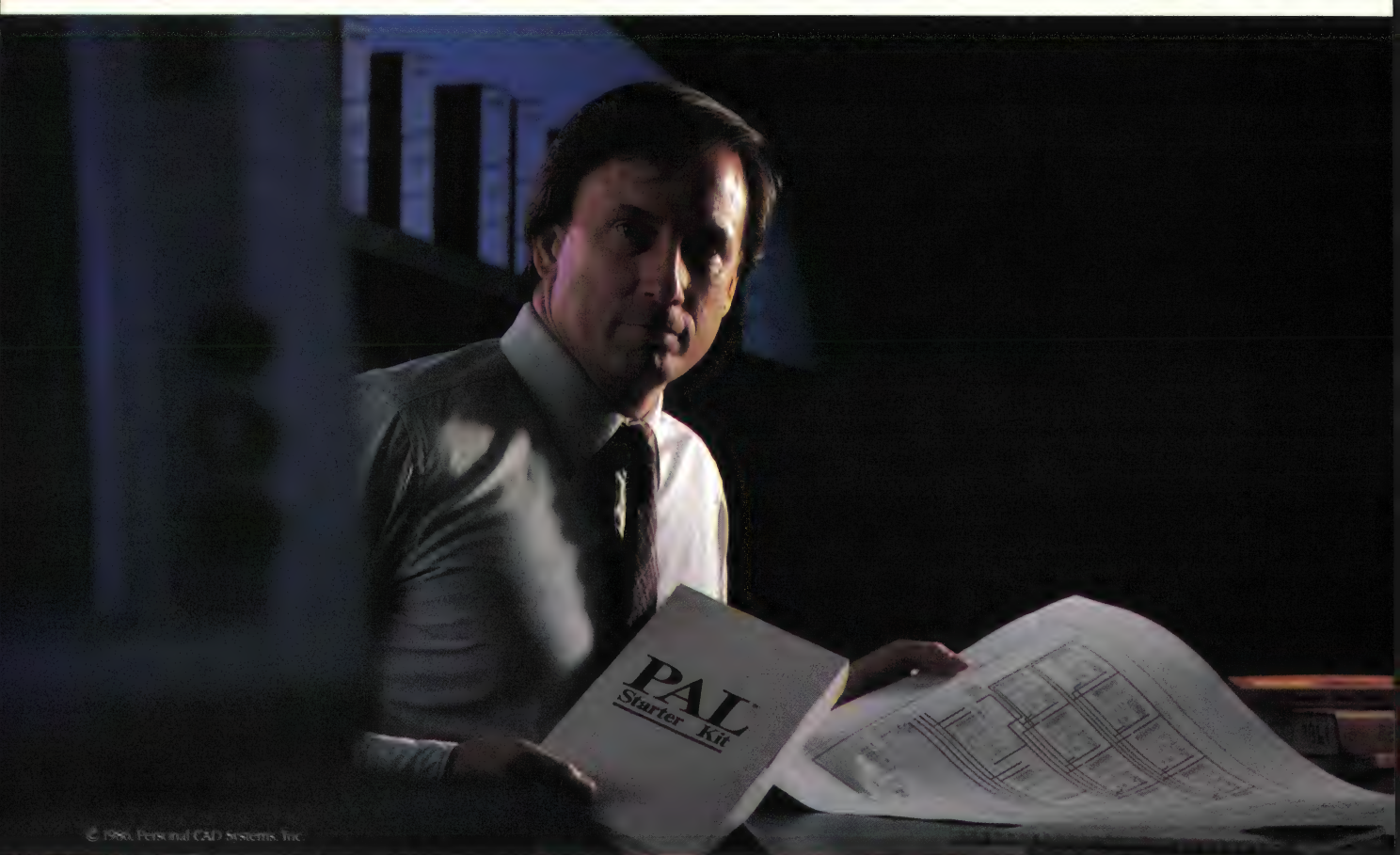
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tion formats, and time-saving shorthand notation. And CUPL works with your choice of device programmer and IBM™-compatible PC-XT or AT. The Starter Kit includes user manual, and full-function software with device

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CALL 800-227-6703 FOR THE FASTEST START.

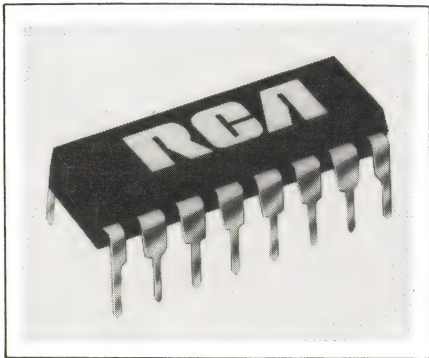
The Starter Kit also includes "My First PAL Design," an informative booklet that gets you off to the right start. All for \$49.95*, plus postage and handling. (If you don't have a device programmer, contact one of the TI-authorized distributors listed in the kit for free programming of the four PAL IC's provided.) For prompt delivery, call 800-227-6703 (from CA: 800-632-7979) and have your VISA or MasterCard handy. Or send check, money order or charge card authorization to: Starter Kit, PO Box 306, Half Moon Bay, CA 94019.

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- *Latch/decoder/driver ICs*
- *4-bit BCD input address converts to a 7-bit-segment output*

Models CD54/74HC/HCT4511 are a pair of BCD-to-7-segment, latch/decoder/driver integrated circuits. The devices convert a 4-bit BCD input address to a 7-bit-segment output for driving either LEDs or incandescent-lamp displays. Both devices are capable of sourcing as much as 7.5 mA of drive current when operating from a 4.5V supply. The 74HC type can source as much as 10 mA because it can operate from a 6V supply. The CD54/74HCT type operates over the TTL power-supply range of 4.5 to 5.5V. CD74HC/HCT4511 in plastic DIP, \$1.25 (100).

RCA, Solid State Div, Rte 202, Somerville, NJ 08876. Phone local office.

INQUIRE DIRECT

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- *Devices operate at 20M flops*
- *Multiply/accumulate throughput is 200 nsec*

The WTL 3132 and WTL 3332 32-bit data-path devices offer 100-nsec multiply/accumulate throughput. Included on a single device are a floating-point multiplier and ALU, a 4-port 32×32-register file, and a look-up table to accommodate divide operations. As a result, board space is one fourth that of previous ICs that performed the same functions. The devices operate at a 20M-flops



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CIRCLE NO 32

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When Syntex Dental Products, Inc., of Valley Forge, Pa., needed a customized, subminiature light source for a high speed, handheld dental drill, they came to Welch Allyn for a brilliant design solution.

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Put twenty-five years of innovative lamp design and low or high volume manufacturing capabilities to work on your custom lamp needs. Experience and state-of-the-art

equipment enable Welch Allyn to customize lamp source, shape, size or performance to precise customer needs—economically. Contact Welch Allyn Lamp Division.

Welch Allyn

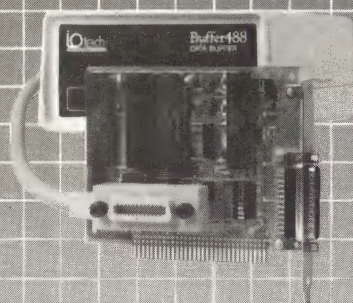
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CIRCLE NO 33

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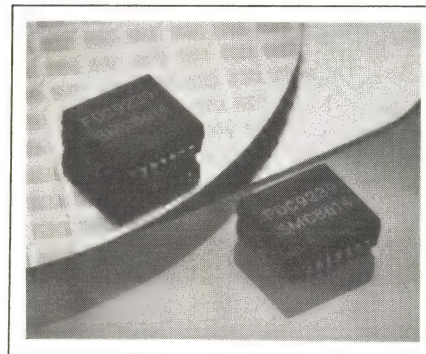
23400 Aurora Road
Cleveland, Ohio 44146
Telex via WUI 6502820864

ICs & SEMICONDUCTORS

rate. The WTL 3332 has three I/O ports; the WTL 3132 has one. The 3132 comes in a 144-lead pin-grid array; the 3332 comes in a 168-lead pin-grid array. Each dissipates less than 1W. WTL 3332, \$425; WTL 3132, \$350 (100).

Weitek Corp., 1060 E Arques Ave, Sunnyvale, CA 94086. Phone (408) 738-8400.

Circle No 389



is a plastic J-leaded version of the FDC9239 enhanced floppy-disk interface circuit for use in surface-mount pc boards. The device requires no external components or tuning adjustments. It's compatible with industry-standard floppy-disk controllers, including the FDC-765A, FDC7265, and FDC179X family. The IC incorporates a precision digital-data separator, write-precompensation logic, and a programmable head-load timer. It also offers hardware and software compatibility with the existing industry-standard FDC9229. The device comes in two versions: the FDC9239/T for 5¼-in. disks, and the FDC9239B/T for 3½-, 5¼-, and 8-in. disks. The devices are available in 28-pin PLCCs and in 20-pin DIPs. Less than \$15 (100). Delivery, six to eight weeks ARO.

Standard Microsystems Corp., 35 Marcus Blvd, Hauppauge, NY 11788. Phone (516) 273-3100. TWX 510-227-8898.

Circle No 391

T1 Repeater



T1 REPEATER

- Acts as a regenerative repeater at 1.544M-bps data rate
- Operates from a single 6.8V supply with drain of 13 mA

The MP5262, a monolithic repeater IC, contains all the active functions required to build one side of a T1 or 2M-bps PCM repeater. The device operates as a regenerative repeater at 1.544M-bps data rates on T1-type PCM telephone lines. The repeater IC operates from a single 6.8V supply with a typical current drain of 13 mA. The clock-extractor section uses a resonant-tank circuit rather than the injection-locked oscillator used by earlier repeater-IC designs. The bipolar output drivers automatically assume the off state in the absence of an input signal. In a 16-pin ceramic DIP, \$6 (100).

Micro Power Systems Inc., 3100 Alfred St, Santa Clara, CA 95054. Phone (408) 727-5350.

Circle No 390

DATA SEPARATOR

- CMOS version of enhanced floppy-disk interface circuit
- Requires no external components or tuning

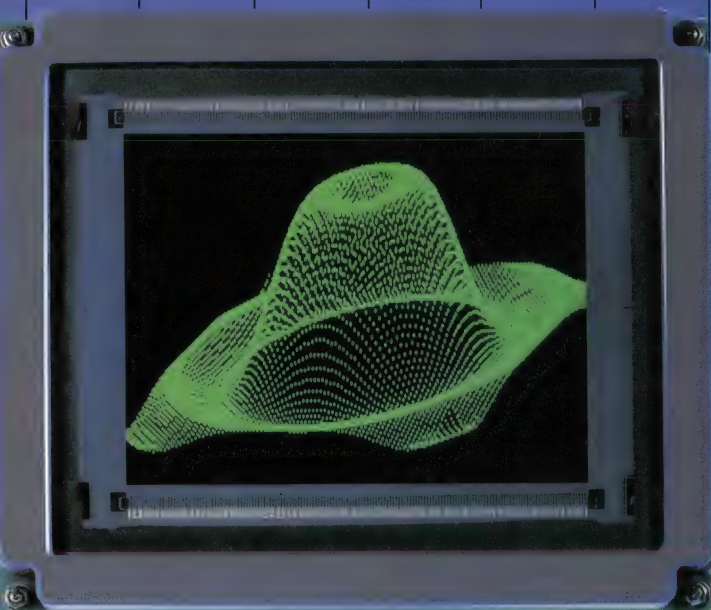
The CMOS FDC9239 data separator

MATH CHIPS

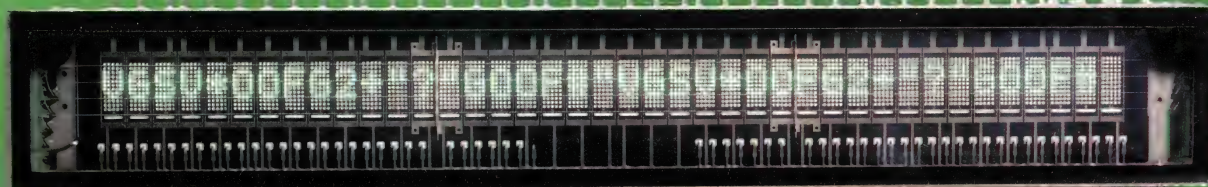
- Multiplier and ALU for 32-bit floating-point chips
- CMOS parts dissipate ½W

The TMC3032 multiplier and the TMC3033 ALU are alternate-source devices for the WTL1032 and WTL1033 32-bit floating-point chips. Both devices come in two versions, one performing 8M flops (standard version) and the other 10M flops (-1 version). Both the multiplier and the ALU operate from a single 5V supply and use

Clear and Bright Vacuum Fluorescent Technology



Graphic Module



Dot Module

FEATURES

1. High resolution and high brightness provides excellent appearance and quality.
2. Light weight and thin package permits compact design.
3. TTL compatibility provides easy interface and self-test and brightness control are standard features.

Graphic Module Series List

Type code	Number of Pixels row × column	Pixel Pitch mm	Effective Display Area mm	System	Alphabetic Display digit × col
GP1005	128 × 64	0,65	83 × 41,4	VFD	20 × 6
GP1006	256 × 64	0,65	166 × 41,4	VFD	40 × 6
GP1009	240 × 64	0,45	107,9 × 28,7	VFD	40 × 6
GP1001	320 × 120	0,375	120 × 45	FLVFD	52 × 12
GP1002	320 × 240	0,375	120 × 90	FLVFD	52 × 24

Inquire for single color Graphic Module

Dot Module Series List

Type code	Characters × Line	Dot Construction	Character Size	Nos. of displaying characters
M20SD01CA	20 × 1	5 × 7 dot	3.5 × 5.0	222
M20SD42CA	20 × 1	5 × 12 dot w/cursor	3.5 × 8.75	222
M40SD02CA	40 × 1	5 × 7 dot w/cursor	3.5 × 5.0	222
M40SD42CA	40 × 1	5 × 12 dot w/cursor	3.5 × 8.75	222
M202SD03CA	20 × 2	5 × 7 dot w/cursor	3.5 × 5.0	222
M402SD04CA	40 × 2	5 × 7 dot w/cursor	3.5 × 5.0	222

Inquire for single color Dot Module



FUTABA
(Europe) GmbH

CIRCLE NO 225

CIRCLE NO 226

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All the splendor of the polar lights.

Plucked by Stanley to make the most colorful and luminous LEDs to date.

Stanley's new generation of LEDs, LCDs and display units are designed to shine with all of the color and luminous splendor of the Polar Lights. Stanley's always been known for wide variety in LEDs and LCDs. And for brightness... our red LED is the world's brightest. Now we're going to be known for color, brightness and variety side by side, and so are you when you put these colorful and bright new design to work for you.



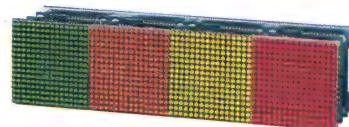
■ Stanley Dot Matrix LCD Module for Graphic Displays

Compact, lightweight and thin, this clear high-contrast display packs plenty of graphic information into your handheld computer, message display equipment, or word processor.



■ Stanley Dot Matrix LCD Module

Full alphanumeric capacity is provided by this high-performance module with 5×7 dot matrix characters. All control, refresh and display functions are executed by an on-board driver.



■ Stanley Large-Sized LED Graphic Display Unit

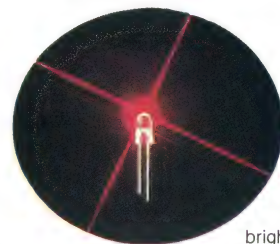
For words and pictures that make a moving display that is big-as-life, these units are X-Y stackable in units of 16×16 dots.



■ Stanley DN304 Ultra-High Power Infrared LED
Features ultra-high radiant power (GaAlAs type), 850nm peak wavelength, and ultra-high-speed response. The wide directivity characteristics ($\Delta\theta = 35$ degrees) enable wide-angle radiation.



■ Stanley DN305 Ultra-High Power Infrared LED
GaAlAs type LED with 850nm peak wavelength, ultra-high-speed response and narrow directivity ($\Delta\theta = 15$ degrees). High radiant intensity ($I_E = 80\text{mW/sr}$).



■ Stanley Hi-Super Bright LED

These are the world's brightest LED. Continuous Liquid Phase Epitaxial Growth Technology produces the aurora-bright intensity of 3000mcd for all your outdoor displays.

STANLEY

STANLEY ELECTRIC CO., LTD.

Electronic Equipment Export Section

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Telex: 2466623 SECTOK J

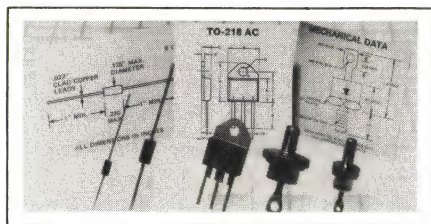
Stanley LED/LCD Agents Overseas ● DENMARK/DITZ SCHWEITZER A-S Tel: 02-453044 Telex: 33257 ● FINLAND/TELETEKNO OY Tel: 0-717566 Telex: 122124 ● FRANCE/A. JAHNICHEN & C^{ie} Tel: 387-59-09 Telex: 290714 ● FR.GERMANY/ELITE ELEKTRONIK UND LICHT GMBH & CO. KG Tel: 08094-18152 Telex: 527353 ● BENELUX/LOHUIS LAMPEN B.V. Tel: 01606-2651 Telex: 54145 ● SWEDEN/AB BETOMA Tel: 08-820280 Telex: 19389 ● SWITZERLAND/DEWALD AG Tel: 01-482711 Telex: 815200 ● UNITED KINGDOM/STC MERCATOR Tel: 0493-844911 Telex: 975441 ● CANADA/DESKIN SALES Tel: 416-475-1412 Telex: TWX610-492-5113 ● U.S.A./A.C. INTERFACE, INC. Tel: 714-841-6090 Telex: 655328

ICs & SEMICONDUCTORS

CMOS, rather than NMOS, technology. Power dissipation is $\frac{1}{2}W$ vs the NMOS devices' $2W$. What's more, the multiplier offers six additional compare and compare-magnitude instructions (previously undefined for the WTL1033). In 64-pin DIPs, \$95 (1000).

TRW, LSI Products Div, Box 2472, La Jolla, CA 92038. Phone (619) 457-1000.

Circle No 392



RECTIFIERS

- PIV ranges from 50 to 1000V
- 25- to 75-nsec recovery

The UF Series of switching rectifiers is available in peak inverse-voltage ratings from 50 to 1000V. The devices spec current-handling capabilities as high as 70A. These high-speed, high-voltage devices allow you to drive a transistor to its full BV_{CBO} rating. Typical forward voltage is as low as 930 mV, and reverse recovery time ranges from 25 to 75 nsec. The operating- and storage-temperature range is -65 to $+175^{\circ}C$. In axial-lead plastic, DO4, DO5, TO3, and TO218 cases, from \$0.70 (1000). Delivery, six weeks ARO.

Semicon Components Inc, 10 North Ave, Burlington, MA 01803. Phone (617) 272-9015.

Circle No 393

STATIC RAMs

- 35-nsec access times
- Offer data retention for power supplies as low as 2V

These three 16k-bit CMOS static RAMs, the V61C16 ($2k \times 8$ bits), V61C68 ($4k \times 4$ bits), and V61C67 ($16k \times 1$ bit), feature access times of

35 nsec. The RAMs use 6-transistor memory cells and offer data retention when operating from supplies as low as 2V. Typical operating current is 30 mA; typical standby current is $0.1 \mu A$; and typical data-retention current is $0.05 \mu A$. In plastic DIPs: V61C16P35L, \$14.51; V61C68P35L, \$12.76; V61C67P35L, \$11 (100).

Vitellic Corp, 3910 N First St, San Jose, CA 95134. Phone (408) 433-6000. TLX 3179461.

Circle No 394

DECODER IC

- Can replace 24-pin PLD and two octal latches
- Programmable address and select inputs

The HPL-82C339 decoder IC draws supply currents of 2 mA/MHz in active mode and $50 \mu A$ in standby mode. The device has a 50-nsec max propagation delay over the -55 to $+125^{\circ}C$ temperature range. In a typical application, the decoder can replace a 24-pin PLD and two octal latches. The seven address inputs to the device are field programmable for either high- or low-true address decoding. The high- and low-bank select inputs are also programmable. The device comes in either a 24-pin ceramic DIP or a 28-pad ceramic LCC. In the DIP, \$11.85 (100).

Harris Corp, Box 883, Melbourne, FL 32919. Phone (305) 727-9100.

Circle No 395

CMOS EPROM

- Offers access speeds of 200, 250, and 350 nsec
- Available in leaded chip carrier and DIP

The VM27C256, a 256k-bit CMOS EPROM, is available in versions with access speeds of 200, 250, and 350 nsec. The manufacturer states that the device is the first 256k-bit



PEARSON Wide Band, Precision CURRENT MONITOR

With a Pearson current monitor and an oscilloscope, you can measure pulse or ac currents from milliamperes to kiloamperes, in any conductor or beam of charged particles, including those at very high voltage levels.

This monitor is physically isolated from the circuit. It is a terminated current transformer whose output voltage precisely follows the current amplitude and waveshape. A typical model gives an amplitude accuracy of $+1\%$, -0% , 20 nanosecond rise time, droop of 0.5% per millisecond, and a 3 db bandwidth of 1 Hz to 35 MHz. Other models feature 2 nanosecond rise time, or a droop as low as 1% per second.

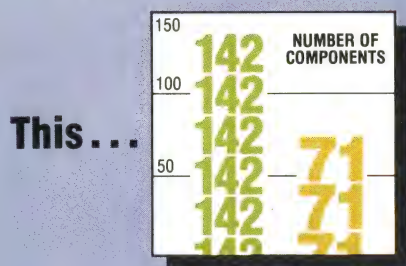
Whether you wish to measure current in a conductor, an electron device, or a particle accelerator, it is likely that one of our off-the-shelf models (ranging from $\frac{1}{2}$ " to $10\frac{3}{4}$ " ID) will do the job. We also provide custom designs to meet individual specifications.

Contact us and we will send you engineering data.

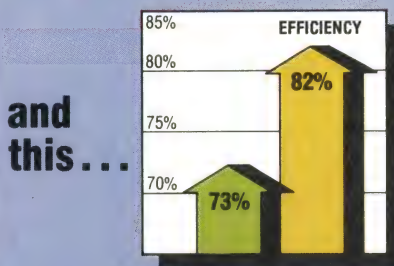
PEARSON ELECTRONICS, INC.

1860 Embarcadero Road
Palo Alto, Calif. 94303, U.S.A.
Telephone (415) 494-6444
Telex 171-412

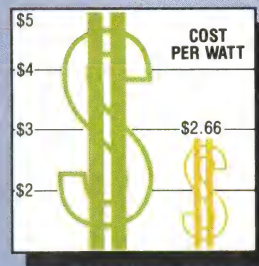
WHAT'S THE DIFFERENCE BETWEEN 1976 AND 1986?



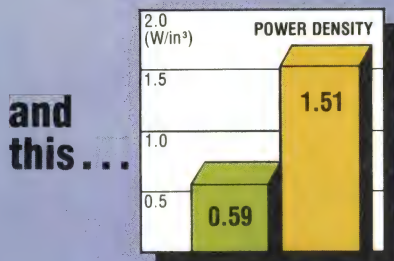
1976 RMD 50 Watts
1986 ERD 60 Watts



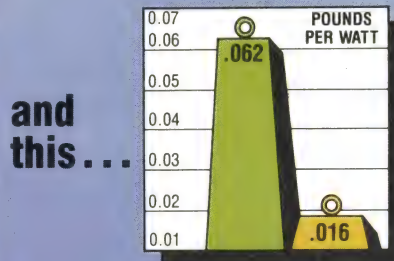
1976 RMD 50 Watts
1986 ERD 60 Watts



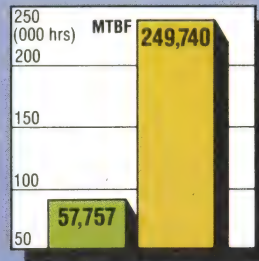
1976 RMD 50 Watts
1986 ERD 60 Watts



1976 RMD 50 Watts
1986 ERD 60 Watts



1976 RMD 50 Watts
1986 ERD 60 Watts



1976 RMD 50 Watts
1986 ERD 60 Watts

Presenting the new d-c to d-c converters Kepco/TDK Series ERD

Actually, the *basic* difference between our new Series ERD and our very popular 10-year-old Series RMD, is 275KHz.

RMD operates at a switching frequency of 25KHz. ERD operates at 300KHz.

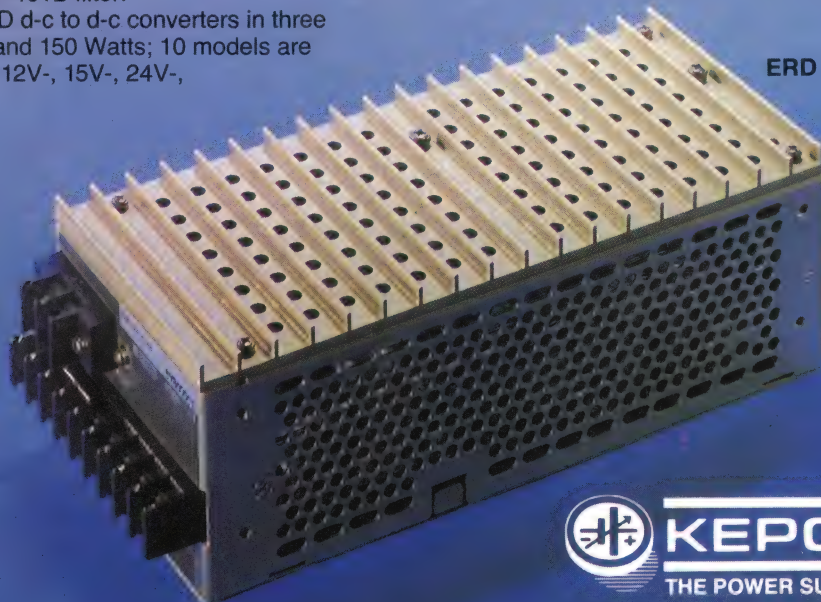
And it's thanks to that 12-fold increase — plus such developments as hybrid microcircuitry and power FETs — that we're able to give you such light, compact, low-priced units with all these features: Adjustable voltage output...remote error sensing...optically isolated remote on-off...overvoltage protection...rectangular current limiting...LED power OK indicator...built-in MIL-STD-461B filter.

We're offering Series ERD d-c to d-c converters in three sizes: 30 Watts, 60 Watts, and 150 Watts; 10 models are available in each size: 5V-, 12V-, 15V-, 24V-, and 48V-output.

These d-c to d-c converters are offered with either 24V inputs or 48V inputs — 30 models in all.

Single unit prices: 30 Watts, \$135; 60 Watts, \$160; 150 Watts, \$225.

OEM quantity discounts available. For complete specifications and 144-page Kepco Applications Handbook and Full Line Catalog, call or write Dept. JGF-12, KEPKO, INC., 131-38 Sanford Avenue, Flushing, NY 11352 USA (718) 461-7000 • TWX #710 582 2631 • FAX (718) 767-1102.



ERD 150 WATT MODEL



KEPCO

THE POWER SUPPLIER™

CIRCLE NO 174



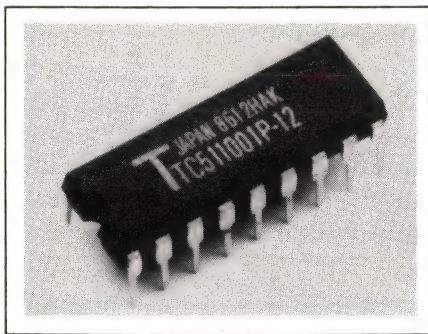
KEPCO'S 40TH YEAR

ICs & SEMI- CONDUCTORS

CMOS EPROM available in a leaded chip carrier (32-lead LCC). It's also available in a 28-pin DIP. The EPROM is organized as 32,768×8 bits and is compatible with most commercial μ Ps. According to the manufacturer, the LCC-housed device offers significant size and weight advantages over other devices: Board-space requirements and weight are reduced by 60% and 30%, respectively. The 250-nsec DIP version, \$203; in LCC, \$243 (100).

VLSI Technology Inc., 1109 McKay Dr, San Jose, CA 95131. Phone (408) 942-1810.

Circle No 396



DYNAMIC RAM

- Organized as 1,048,576 1-bit words
- Specs 100- or 120-nsec access time

The TC511001P dynamic RAM is organized as 1,048,576 1-bit words. It's available with 100- or 120-nsec access-time specs. In nibble mode, access time is 20 or 25 nsec, respectively to the 100- and 12-nsec versions, for each of four successive bits of data. The device operates from a single $5V \pm 10\%$ power supply. Maximum operating power is 330 mW for the 100-nsec part and 275 mW for the 120-nsec device. Standby power is 5.5 mW for either version. In an 18-pin plastic DIP, \$77 (100).

Toshiba America Inc., 2692 Dow Ave, Tustin, CA 92680. Phone (714) 832-6300.

Circle No 397

tube•ology

t(y)üb-äl-ə-jē [see **UNIFORM TUBES**] 1: the science of cutting, closing, reducing, expanding, corseting, flaring, flanging, slotting, lancing, punching, notching, flattening, piercing, rounding, dimpling, bulging, beading, bending, and coiling **miniature tubing**. 2: technology used to meet the most exacting design requirements for tubing. 3: a means of minimizing component costs.



For further definition
call or write today.

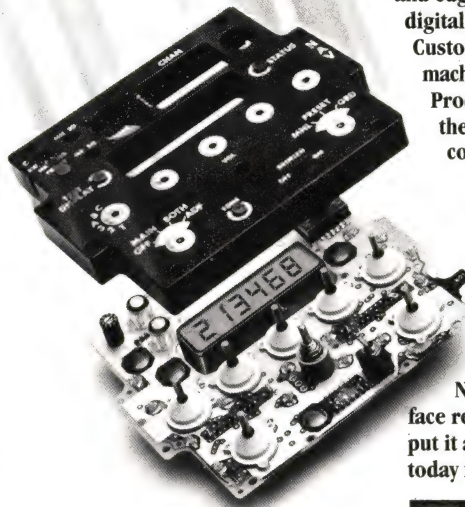


UNIFORM TUBES, INC.

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CIRCLE NO 35

INTERFACE PRODUCTS PUTS IT ALL TOGETHER!



Illuminated keyboards, annunciators and edgelighted panels. Integrated displays, digital readouts and special components. Custom or standard. Whatever your man/machine interface requirement, Interface Products can design and build it—from the entire black box to individual components.

Interface Products provides products for use in military, aerospace and commercial applications. From avionics displays to process controls, our products provide a reliable and functional interface between the operator and the system.

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NEW PRODUCTS

COMPUTER-SYSTEM SUBASSEMBLIES



SUBSYSTEM KIT

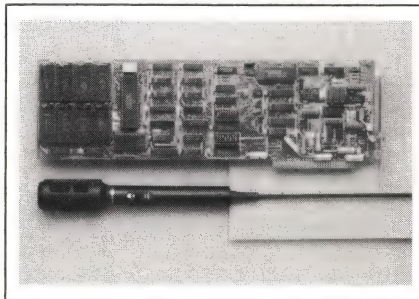
- Tape backup for PCs
- 319M bytes of backup

The ATS kit provides the IBM PC/AT with high-capacity disk storage and a cartridge streaming-tape drive for backup. It offers backup storage capacities of 112M, 146M, or 319M bytes (formatted). Installation requires one slot and one DMA channel. The ATS comprises three models: the /140-T, the /170-T, and the /380-T. Each kit includes a 5¼-in. ST506 or ESDI Winchester disk drive with the company's MD01 or MD21 disk controller; a ¼-in. cartridge streaming-tape drive with the company's MT02 tape controller; the company's IB02 host adapter; and required cables. Each kit also includes a mounting frame for the MD01 or MD21 disk controller and rails with which to install the disk- and tape-drive peripherals in the PC/AT. The MD01 controller provides a 5M-bps data-access rate from the disk and ensures data integrity. It also manages multitask-

ing operations and provides a high-speed data buffer. The MD21 controller features a 32k-byte buffer, defect management, and bad-block replacement. \$6175 to \$11,100.

Emulex Corp., Box 6725, Costa Mesa, CA 92626. Phone (800) 368-5393; in CA, (714) 662-5600.

Circle No 398



ENHANCEMENT BOARD

- Controls IBM PCs and compatibles with voice commands
- 0.2-sec conversion time

The Little Dictator enhancement board allows you to control an IBM PC/XT, PC/AT, or a compatible

computer with voice commands. You can program the board to respond to as many as 500 commands and recognize as many as 64 voice patterns. The board converts voice commands to computer instructions in 0.2 sec. If you need more commands or voice recognition patterns, you can plug additional boards into your computer. You can store menus, submenus, and menu extensions having as many as 50 commands per menu; you retain normal keyboard operation. To use the board, you need 64k bytes of memory. Including microphone, \$599.

Computer Peripherals Inc., 2635 Lavery Ct, Newbury Park, CA 91320. Phone (800) 854-7600; in CA, (805) 499-5751.

Circle No 399

RELAY BOARD

- Relay output board for the STD Bus
- Switches low-level signals, such as thermocouples

The RLY-24 is a 24-channel relay output board for the STD Bus. You can use it to switch low-level signals such as thermocouples and analog inputs, and you can use it in such applications as gain-control circuits, where current leakage can be a problem. Other applications include switching nodes for automated testing, changing power-supply voltages, and use as an RS-232C multiplexer. The board's 2A, 250V relay outputs can operate either normally open or normally closed. Its contacts, rated at 250V ac or 220V dc, connect to circuits via a 50-pin header. Other features include selectable port addressing and 0.7A max power consumption. \$265.

Computer Dynamics Inc., 105 S Main St, Greer, SC 29651. Phone (803) 877-7471.

Circle No 400

Why these new handheld thermometers give the competition chills.



The chance of finding thermometers that can match the new **Fluke 50 Series** for price and performance is like finding snowballs in August — slim to none.

Take the dual-input Fluke 52. With its exclusive features, you can sequentially **SCAN** the readouts of two temperature inputs and their difference, *and* automatically **RECORD** the minimum and maximum from any one channel for up to 1,200 hours.

Or there's the single-input Fluke 51. Like the 52, it offers 0.1% accuracy and resolution to 1/10th of a degree with excellent repeatability.

Both accept any standard J or K type thermocouple probe, and have offset pots for easy on-site calibration. Plus they're built to last. With a 3-year warranty, the longest in the industry.

No wonder they give the competition chills. Starting at a cool \$119, they're the hottest new thermometers on the market.

They're on the shelves at your local supplier, so get yours now.

Or for more information, call toll-free **1-800-227-3800, Ext. 229**. From outside the U.S. call 1-402-496-1350, Ext. 229.

**FROM THE WORLD LEADER IN
HANDHELD TEST INSTRUMENTS.**



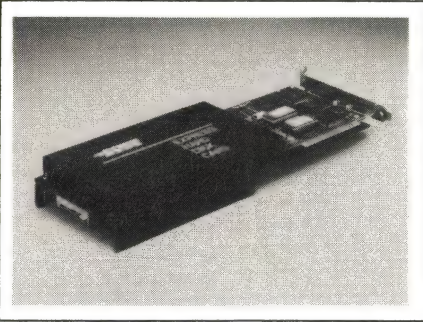
Fluke 51 Single Input



Fluke 52 Dual Input

Measurement range: K-type: -200°C to +1370°C (-328°F to +2498°F) J-type: -200°C to +760°C (-328°F to +1400°F)
Accuracy: K-type is $\pm(0.1\% \text{ of reading} + 0.7^\circ\text{C or } 1.3^\circ\text{F})$ J-type is $\pm(0.1\% \text{ of reading} + 0.8^\circ\text{C or } 1.4^\circ\text{F})$
°C or °F Selectable
Hold Mode
Scan, Differential, and Min/Max Recording Modes (52 only)
Standard mini-connector input
1200 hour 9V battery life
3-year warranty
General-purpose K-type bead probe included (two with 52)





HARD-DISK CARDS

- *Furnish 20M to 60M bytes of storage*
- *Add to existing hard-disk storage space*

This family of hard-disk cards ranges from the 20M-byte AT Backup DiskCard to the 60M-byte Hard DiskCard. The boards offer 60- to

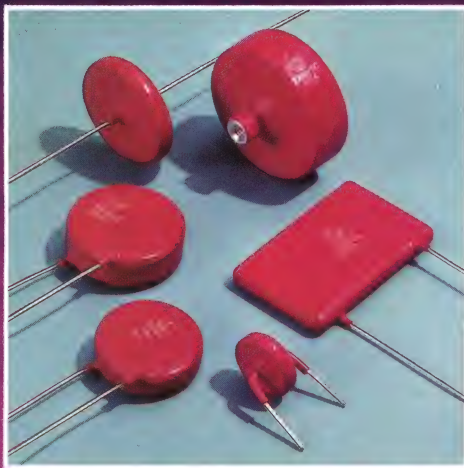
80-msec average access speeds at 5M- and 7.5M-bps transfer rates. Each board comes with software, cables, and instructions. When power is on, the boards have between 6 and 10g shock resistance; when power is off, their shock resistance is 50 to 60g. Using the company's Coalesce software, you can add the 20M- or 30M-byte card to a computer that contains a hard disk. When combined, the two units work together as one disk and provide as much as 144M bytes of hard-disk capacity. The company's backup-disk card comes with Auto Disk-Save software, which lets you identify backup files by date, time, archive bit, subdirectory, file name or groups of files, or any name combination using DOS wild cards. All Hard DiskCards include the DS Backup program. AT Backup DiskCard, \$449; Hard DiskCard, \$1095.

Express Systems Inc., 1254 Remington Rd, Schaumburg, IL 60195. Phone (800) 341-7549; in IL, (312) 882-7733.

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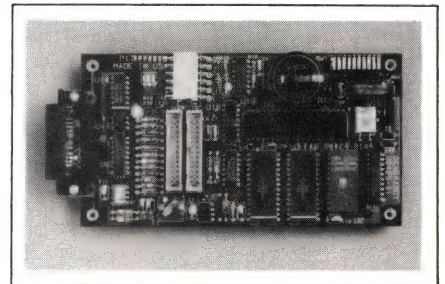
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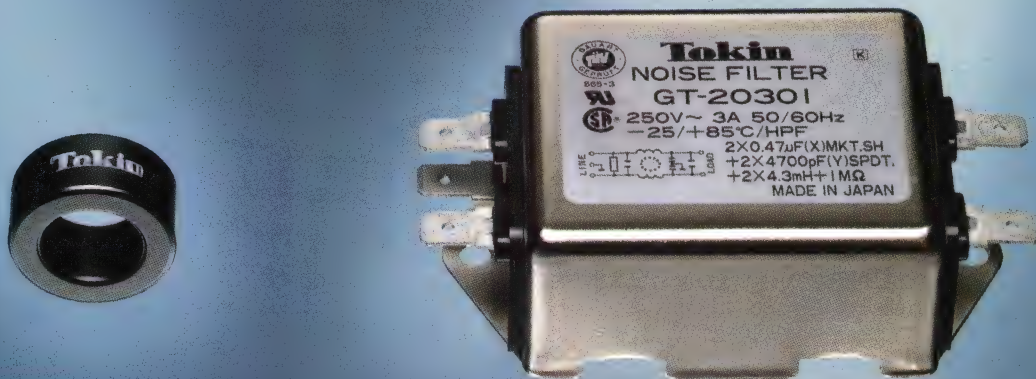
P.O. Box 37144, Tucson, AZ 85740-7144
602-744-0400 Telex: (RCA) 299-640



DATA CONVERTER

- *Stores 16,000 characters, or 127 messages*
- *Has selectable rates of 110, 300, 600, 1200, 2400, 4800, 9600 baud*

The USDCM/M (universal serial data-converter module with memory) provides serial-to-parallel data conversion (20-mA current-loop, RS-232C, or RS-422A), and is pin-for-pin compatible with the company's vacuum-fluorescent and deplasma display modules. It can address two display units either individually or simultaneously. Bat-



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The EMC technical services available through our ETCL in San Jose, Calif. include measurement and countermeasures conforming to international standards such as FCC and CISPR in addition to Japanese and other standards, also the prototype development of EMC and Transformers/Inductors Components. For details contact Tokin America Inc.

EMI/EMC Power-line Filters



GL-EP type



MA type



GL-F type



SC-J type



SU-Coil

EMI/EMC Data-line Filters



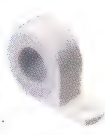
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DIP-Filter



Filter Capacitor



ESD-R type



Bead Inductors



ESD-FPL type

Tokin Corporation

Head Office: Hazama Bldg., 5-8, Ni-chome, Kita-aoyama, Minato-ku, Tokyo 107, Japan
Tel.: Tokyo (03) 402-6166 Telex: 02422695 TOKIN J

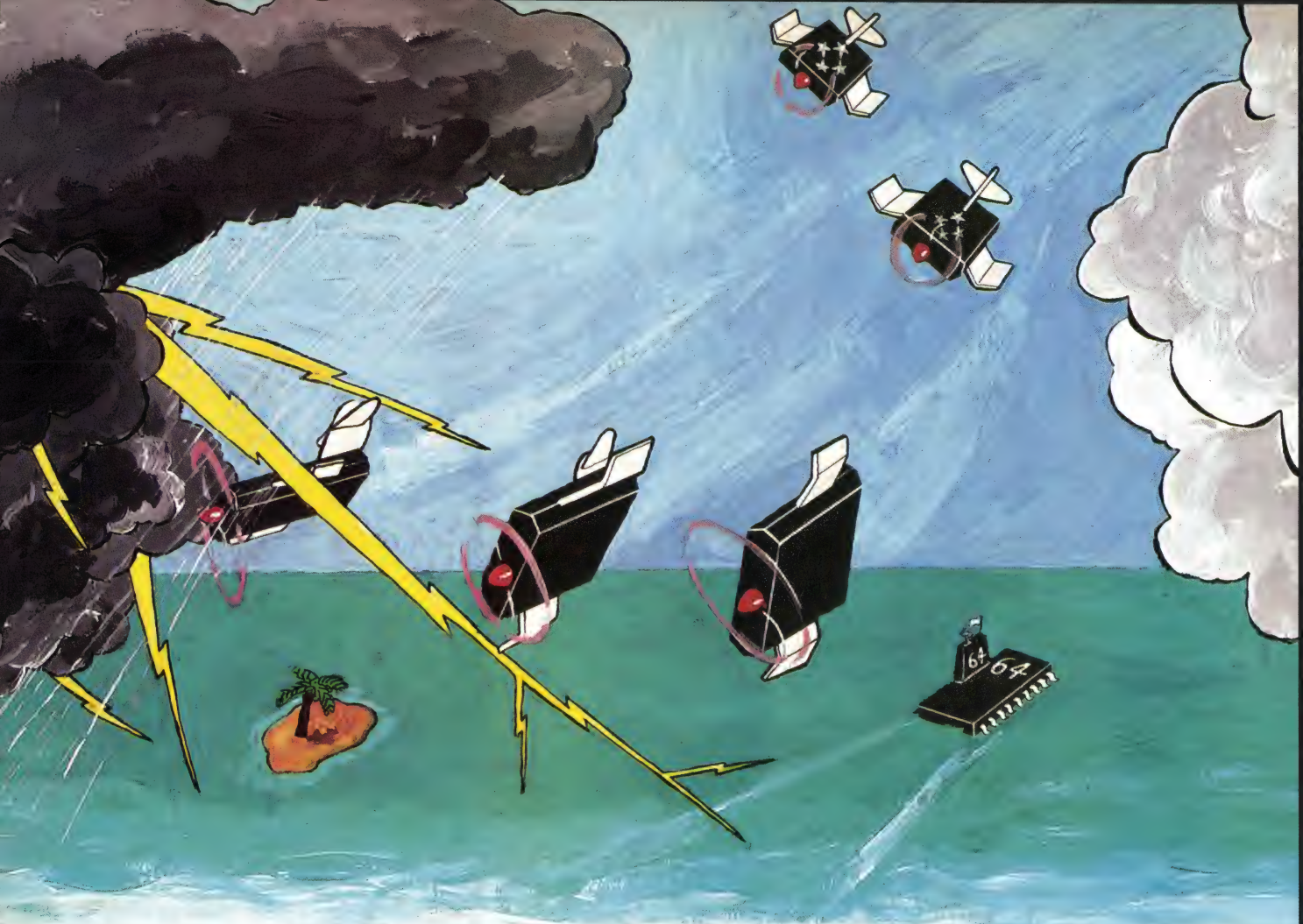
Tokin America Inc.

2261 Fortune Drive, San Jose, California 95131 U.S.A. Tel.: 408-946-4887

You can reach our agents by phone:

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Tokin



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Anywhere transients are a threat and space or production time are problems, these new TransZorb suppressors stand ready to help. They'll give your ICs, MOS devices, and other voltage sensitive devices the complete transient protection they need and take up very little board space while doing it.

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Two models are available: the SMB series can dissipate 600 watts during a millisecond pulse, while the SMC series can handle 1500. Both are offered with voltage ratings from 5V to 220V and can be supplied with wide "J" bend or gull-wing leads.

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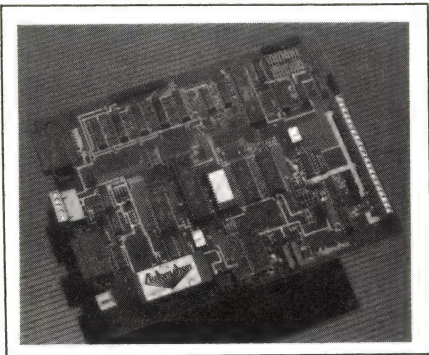
CIRCLE NO 175

COMPUTER-SYSTEM SUBASSEMBLIES

tery-backed RAM stores 16,000 characters, totaling as many as 127 messages; modules can display these messages in response to command sequences from your system. The board features selectable rates of 110, 300, 600, 1200, 2400, 4800, and 9600 baud, as well as a selectable parity format. Individual card addressing allows one host output port to control as many as 127 converters via daisy chaining or in parallel. The unit also has a D-subminiature I/O connector and operates from 5V dc at 300 mA. \$152 (100). Delivery, four to six weeks ARO.

IEE Inc., Industrial Products Div, 7740 Lemona Ave, Van Nuys, CA 91405. Phone (818) 787-0311. TWX 910-495-1707.

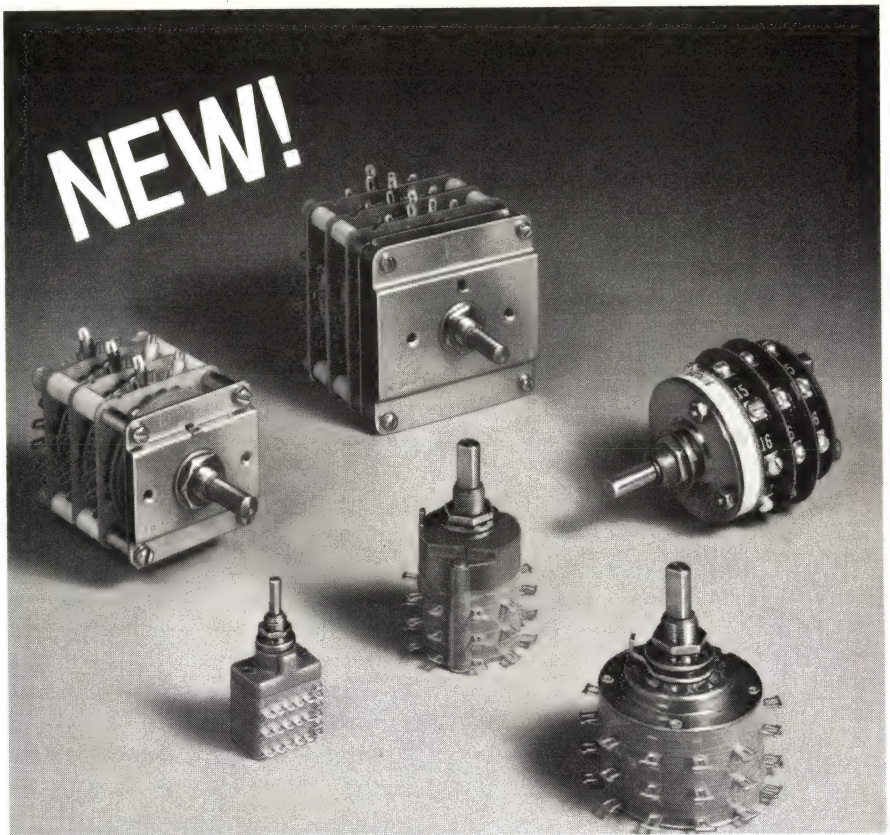
Circle No 402



PERIPHERAL BOARD

- *Communicates over serial I/O channels*
- *Supplies digital and analog I/O lines*

Operating on RS-232C or RS-422/485 serial communication lines, the MDL-16 data-acquisition board offers both analog and digital I/O lines. The board provides either 16 single-ended or eight differential 12-bit analog inputs as well as 11 single-ended 8-bit analog inputs, 16 digital input lines, and 16 digital output lines. Besides offering 12-bit resolution, the A/D converter has $\pm 1/2$ LSB linearity and accuracy at a conversion rate of 10,000 samples/sec. The board also supplies an 8-bit D/A channel. The RS-232C and RS-



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CIRCLE NO 29

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422/485 serial ports transfer data at 1200 to 19.2k baud. An RS-422/485 twisted-pair network can link as many as 45 stations. The board also features a 16k-byte RAM buffer and programmable setpoints for analog inputs. Options include a switching power supply, a battery-backed real-time clock, a battery-backed RAM, and a 300/1200-baud autoanswer/autodial onboard modem. \$449.

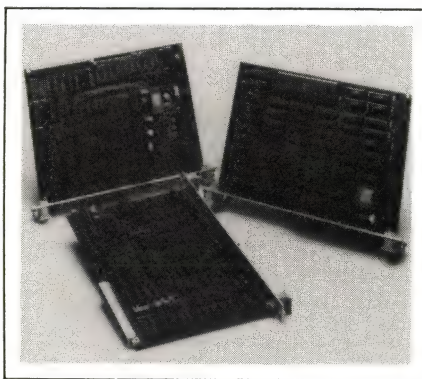
The Automation Group Inc.
848-0 Nandino Blvd, Lexington, KY 40511. Phone (606) 252-6753.

Circle No 403

VIDEO BOARDS

- Process 512×512-pixel images in real time
- Provide an output for a 1024-pseudocolor palette

The RTI-400 Series includes the PX-401V intelligent pipelined pixel



processor, the AS-401V analog subsystem for video inputs and outputs, and two image-memory boards, the DS-401V and DS-441V, for machine vision and image processing. The PX401V is a 10-MHz, 16-bit, pipelined pixel processor that performs arithmetic operations, such as And, Or, and XOR, as well as conditional processing operations. It also features a 12-bit multiplier and a 16-bit look-up table for high-precision linear and nonlinear operations on 8- and 16-bit data

streams. The AS-401V analog subsystem digitizes images to a 512×512-pixel resolution with 8-bit accuracy. The analog subsystem accepts analog signals from as many as four devices, such as cameras or videocassette recorders. Input and output look-up tables provide point-processing operations and input-signal correction. An output look-up table lets you select a 1024-pseudocolor palette from more than 16 million colors. Two separate memory boards are available. The DS-401V stores one 512×512×8-bit image; the DS-441V stores four. Both memory boards feature hardware pan and scroll on a per-pixel basis. A typical vision-engine subsystem consists of one AS-401V, one PX-401V, and three or four frame stores. The RTILIB/400 software is a real-time image-processing and machine-vision subroutine package that contains more than 300 C-callable routines. PX-401V,

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CIRCLE NO 50



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The amazing Casio FX-4000P programmable scientific calculator. In power, it's comparable to the most highly touted calculators on the market today.

It offers you 160 total functions, including 83 scientific functions, such as hexadecimal/decimal/binary/octal conversions, standard deviation and regression analysis.

Making it easier to deal with long computations, its 12 character

alpha-numeric display scrolls to 79 characters and its instant formula replay feature lets you review, edit and replay your formula at the touch of a button. It even has an answer key that stores your last computed value.

And to make things still easier, the FX-4000P has a "perfect entry" system, which allows you to enter and display a formula exactly as written.

Plus, it has a non-volatile 550 step program memory with 10 program

divisions. This allows 10 different programs to be stored at once.

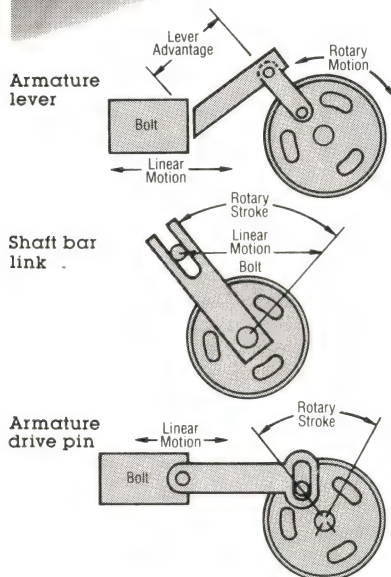
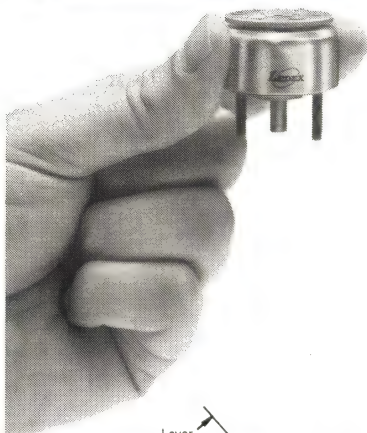
And it includes up to 94 data memories, which are invaluable for statistical analysis.

Finding all this power at your fingertips is remarkable enough, let alone at half the price of some competitors. If you can put your finger on a scientific calculator that gives you more power at any price, by all means buy it.

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	CASIO FX-4000P	HP 15C	TI 60
Functions	160	115	124
Display	12 Scrolls to 79	7 + 2	10 + 2
Memory	550 Step	448 Step	84 Step
Formula Replay	Yes	No	No
Computer Math	Yes	No	Some

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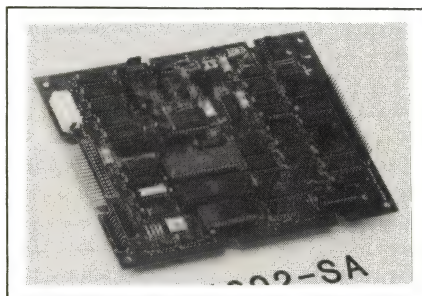
CIRCLE NO 51

COMPUTER-SYSTEM SUBASSEMBLIES

\$3495; AS-401V, \$2995; DS-401V, \$2495; DS-441V, \$3495; RTILIB/400 \$1500.

Recognition Technology Inc.,
335 Fiske St, Holliston, MA 01746.
Phone (617) 429-7804.

Circle No 404



CONTROLLER BOARD

- *Dual-hard-disk control*
- *SASI interface*

The SMC4202-SA dual Winchester disk controller board for the SASI interface controls as many as two Winchester disk drives through the ST-506/ST-412 interface. It's plug compatible with the SASI bus. Based on the SMC HDC9224 universal disk controller and the SMC HDC9226 digital data separator, the board provides data error detection and correction to ensure data integrity. The board also provides adjustment-free onboard data separation, selectable write precompensation, and DMA transfer capability. \$195.

Standard Microsystems Corp., 35 Marcus Blvd, Hauppauge, NY 11788. Phone (516) 273-3100. TWX 510-227-8898.

Circle No 405

TRANSFER DRIVE

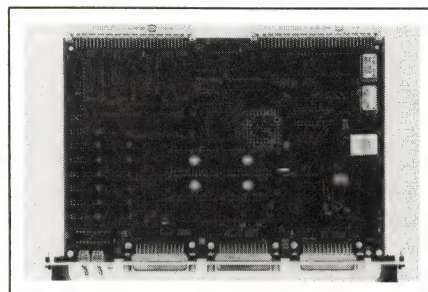
- *Has 12.29M-byte/sec transfer rate*
- *Lets you connect 4- or 5-channel parallel-data transfers*

The M2360A 689M-byte parallel-transfer drive is a 10½-in. disk drive that has a 12.29M-byte/sec transfer rate, an 18-msec positioning time, and 1-, 4-, or 5-channel

data transfer. Using rotational synchronization, all M2360A drives connected to a controller act as a single drive, thereby increasing the effective data-transfer rate of the disk subsystem. You can connect as many as eight M2360As in a starburst or daisy-chain configuration. You can also connect 4- or 5-channel parallel-data transfers by setting a switch on the maintenance panel. \$19,000 (OEM qty).

Fujitsu America Inc., 3055 Orchard Dr, San Jose, CA 95134. Phone (408) 946-8777. TWX 910-338-2193.

Circle No 406



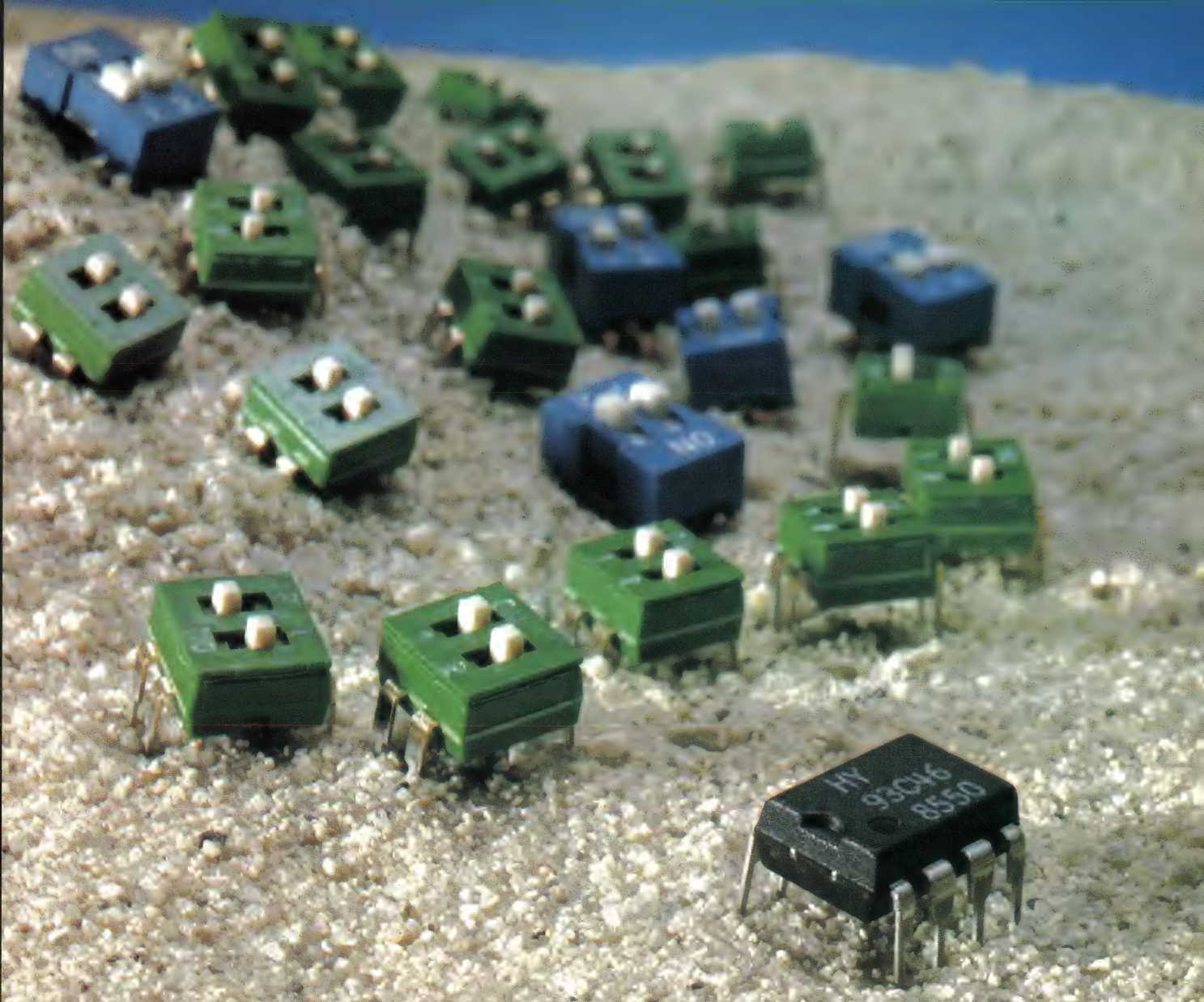
VME CPU BOARD

- *Offers a 68000 or 68010 μ P*
- *Includes assembler/disassembler*

Incorporating 68000 or 68010 processors, the CPU-6 series offers 512k bytes of dedicated onboard dynamic RAM that permits zero-wait-state operation at 8 MHz and 1-wait-state operation at 12.5 MHz. All software that executes on the manufacturer's CPU-1 computer also runs on the CPU-6 series without modification. Four 28-pin JEDEC sockets accommodate high-density 27512 EPROMs or byte-wide static RAMs. The EPROMs supply as many as 256k bytes of user and system memory. Three RS-232C serial ports and one parallel port accommodate external I/O devices. The computer includes firmware that supplies a 16k-byte monitor and a line-at-a-time assembler/disassembler. \$1845.

Force Computers Inc., 727 University Ave, Los Gatos, CA 95030. Phone (408) 354-3410.

Circle No 407



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Hyundai introduces a 1K EEPROM that performs the same function as several DIP switches.

The HY93C46 1K Serial EEPROM is intended for applications which require non-volatile storage of data. Our EEPROM is a 1024-bit memory organized as 64 registers of 16 bits each.

Programming for switch function is achieved by writing either a 1 or 0 in the appropriate register. Because data is written in or read out serially, no address or data bus is required—resulting in an 8-lead DIP.

Hyundai's HY93C46 is fabricated in floating-gate CMOS EEPROM technology for low power consumption, and operates on a single 5V supply. The programming voltage is generated on-chip and controlled by internal logic.

So, if you need switch setup capability, why fill your board with DIP switch components when you can use a single chip? All it takes is one HY93C46—to save component cost, reduce boards space, lower power dissipation, and improve system reliability.

The HY93C46 accommodates up to 10,000 erase/write cycles per register. Function reprogramming is easily accomplished through seven 9-bit instructions that control read, write and erase operations.

A practical alternative, the HY93C46 is available now. And Hyundai is as near as your telephone.

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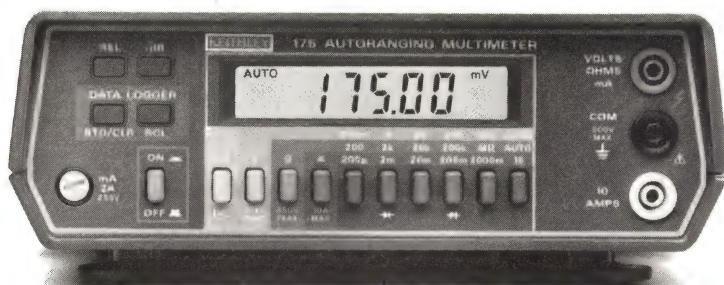
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Keithley Instruments, Instruments Division, 28775 Aurora Road, Cleveland, Ohio 44139. Phone: (216) 248-0400.



Model 175 Autoranging DMM

- ☐ 4½ digits
- ☐ Data logger, relative reference, dB
- ☐ IEEE-488 interface option
- ☐ Rechargeable battery pack option
- ☐ \$439

Model 197 Autoranging Microvolt DMM

- ☐ 5½ digits, 220,000 count display
- ☐ 1µV, 1mΩ, 1nA sensitivity
- ☐ Data logger, relative reference, dB
- ☐ Analog & IEEE-488 output option
- ☐ \$595



Model 193 System DMM

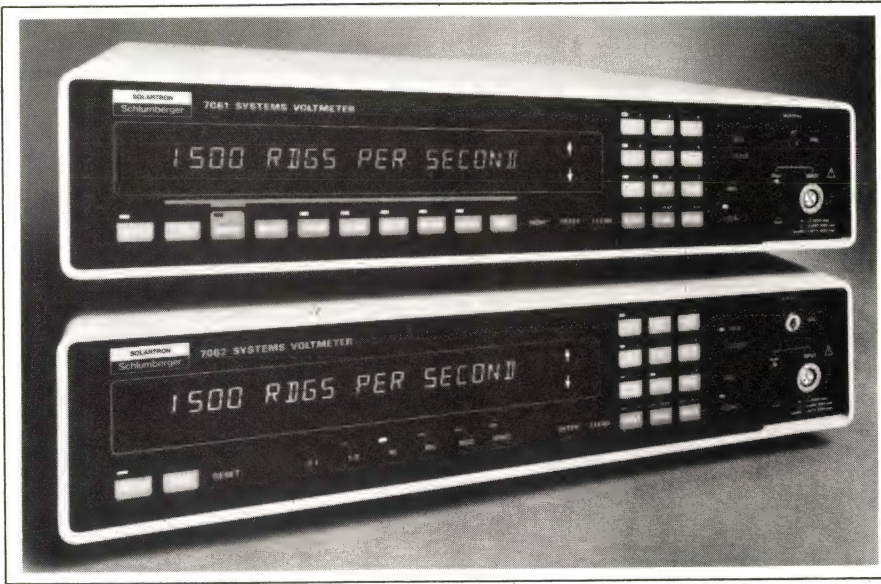
- ☐ 3½ to 6½ digits
- ☐ 2,200,000 counts
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- ☐ TRANSLATOR software
- ☐ 9 measurement functions
- ☐ 500 reading memory
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CIRCLE NO 228

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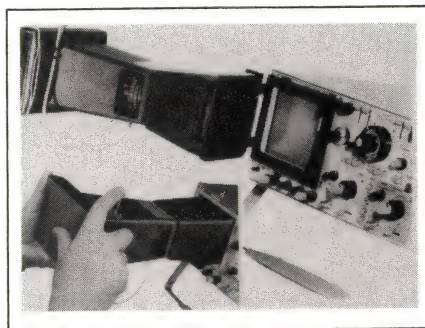
- Captures 1500 readings/sec
- Can generate 300 readings/sec

The 7061 system digital multimeter provides dc measurements to 7½-digit resolution and measurements to 6½ digits for all other functions. It can capture 1500 readings/sec in an internal memory that has a capacity of 8000 readings, and it can generate 300 readings/sec on the IEEE-488 bus. Response time to an external trigger is <3 msec; the instrument signals an alarm in 1 msec. The instrument will track measurements against a preset input level and record measurements before and after the trigger event. A math and statistics package can then format results. A ratio function lets you compare a measurement to any other measurement. DC voltages from 100 nV to 1000V are measured to an accuracy of 0.0005%. A true rms ac function provides readings from 1 to 750V over a 10-Hz to 500-kHz bandwidth with 10-to-1 crest-factor capability. Other measurement functions include ac/dc current, ohms, and temperature. A built-in scanner option houses 16 channels in addition

to the main and reference inputs. The meter can scan all 18 channels in any sequence at a rate of 300 channels/sec. \$2795.

Solartron Instruments, 2 Westchester Plaza, Elmsford, NY 10523. Phone (914) 592-9168.

Circle No 408



SCOPE CAMERA

- Handheld or bezel mounted
- F-stops from f3.5 to f16

The Model 7000 scope camera attaches to oscilloscopes, test instruments such as logic analyzers, and computer terminals as large as 12 in. (diagonal). The device can be handheld or can be bezel mounted on most oscilloscopes when used with specific bezel adapters. The device uses B&W or color Po-

laroid film. It includes a variable shutter control from 1/125 to 1 sec plus B (bulb flash time), and f-stops from f3.5 to f16. When mounted, you can swing the camera to either side to allow yourself an unobstructed view of the display. \$434, including hood.

Soltec Distribution, Box 818, Sun Valley, CA 91353. Phone (800) 525-5554; in CA, (818) 764-5400. TLX 4943094.

Circle No 409

DS-1 TESTER

- Monitors without interrupting service
- Has built-in sine-wave oscillator

When equipped with the Option 2 PCM channel-access receiver, the Model 100P analog-transmission test set can monitor any in-service T-carrier DS-1 line without interrupting service. You can use a switch to monitor the repeater's low-level input or high-level output signal for decoding. The Option 2's diagnostic section shows the status of the bit stream; you can isolate an individual channel by means of thumbwheel selection. The Option 2 includes a 4-digit counter to count frame errors and bipolar violations. Once decoded, you can feed the channel's demuxed output into the 100P, which meets the specifications of Bell Technical Reference PUB 41009 and can measure noise, notched noise, noise-to-ground values, and frequency. The 100P is portable and has a built-in sine-wave oscillator. A talk-dial hold circuit is provided to allow you to dial and hold a voice circuit when making noise or net-loss measurements. Model 100P with Option 2, \$2400; Option 2 only, \$1050.

Design Development Inc, 1440 Atteberry Lane, San Jose, CA 95131. Phone (408) 946-6770.

Circle No 410

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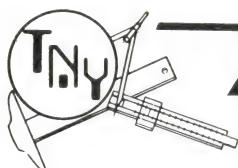
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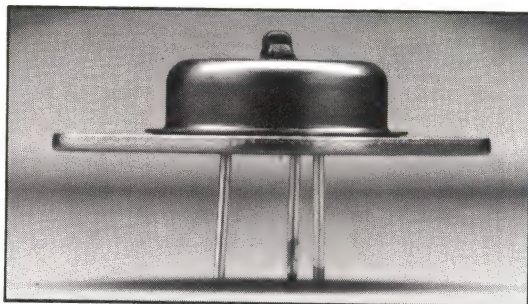
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CIRCLE NO 52

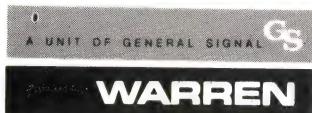
Finally—a solid-state airflow switch with the features you want.



No more thermal management problems. Because Warren GV has designed a PC board-mounted, solid-state airflow switch with efficiency built in standard models where you need it the most.

Our new, low-profile TO-3 unit operates on a 5.00 VDC supply, with a wide range of velocity settings available: 50 FPM to 1500 FPM. It offers low-power dissipation, high switching capability of 100MA standard, plus greater sensitivity. And, it's environmentally protected, ambient compensated and not position sensitive.

For complete technical data, call or write us today.



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Livingston, NJ 07039 ■ (201) 992-6200
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CIRCLE NO 53

INSTRUMENTATION & POWER SOURCES



3½-DIGIT DMM

- Measures to 1000V dc, 750V ac, 10A ac/dc, 2 MΩ
- Features autoranging option

The Model 9370 digital multimeter offers autoranging or manual selection of voltage and resistance ranges. The device measures to 1000V dc (five ranges); 750V ac (four ranges); 10A ac and dc (two ranges); and 2 MΩ (five high-power and four low-power ranges). The memory mode provides as many as 99 counts of zero offset. Low- and high-energy fusing are also furnished. Basic accuracy is 0.5%. Including a 9V battery and color-coded test leads with screw-on alligator clips, \$59.

Mercer Electronics, 859 Dundee Ave, Elgin, IL 60120. Phone (312) 697-2265.

Circle No 411

SCOPE DIGITIZER

- Works with IBM PC
- Generates an NTSC-standard RS-170 signal

The Digitizing Camera System (DCS) digitizes traces of analog oscilloscopes at 1 GHz. The device connects to the oscilloscope bezel like a conventional CRT camera. The system's video camera reads the light given off by the CRT and

Light years ahead

- DC-DC Converters
- 25-40 Watts
- Singles, duals, triples
- 19-35V or 39-64V input
- Parallelable

- Ultra reliability
MTBF 2,000,000 Hrs
- -45°C to $+85^{\circ}\text{C}$
without derating
- Isolated and nonisolated
versions available

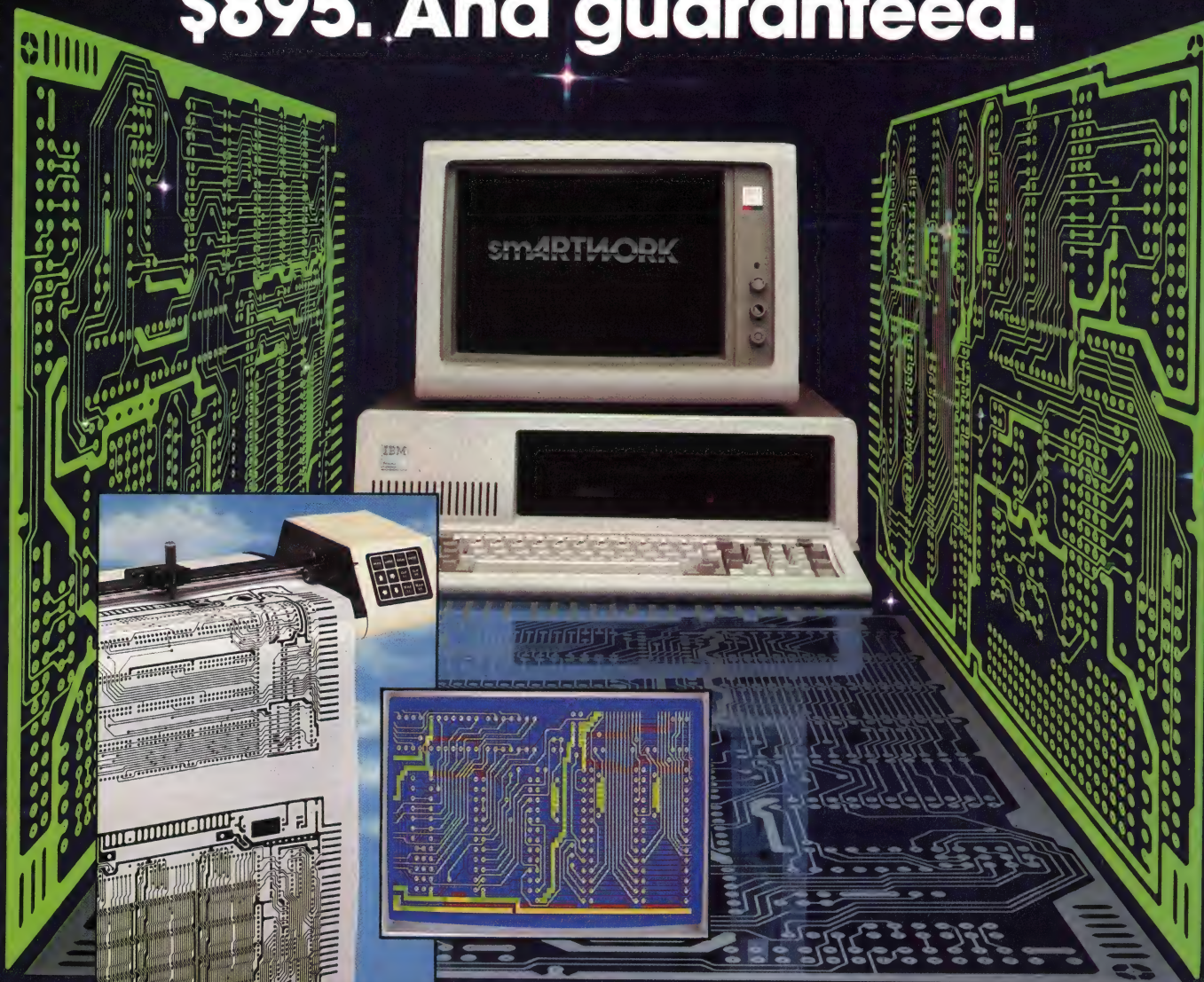
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DC-DC converters
Please circle **73**

For information on
AC-DC Eurocard SMPS 60-100W
Single, Dual and Triple outputs
Please circle **84**

RIFA Inc
Greenwich Office Park 3
P.O. Box 3110
Greenwich, CT 06836-3110
(203) 625-7300

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That's why we offer every design engineer a *thirty-day money-back no-nonsense guarantee*.

smARTWORK® advantages:

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- ☐ Production-quality 2X artwork from a pen-and-ink plotter

- ☐ Prototype-quality 2X artwork from a dot-matrix printer
- ☐ Easy to learn and operate, yet capable of sophisticated layouts
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- ☐ Multicolor or black-and-white display

System Requirements:

- ☐ IBM Personal Computer, XT, or AT with 320K RAM, 2 disk drives, and DOS Version 2.0 or later
- ☐ IBM Color/Graphics Adapter with RGB color or black-and-white monitor
- ☐ IBM Graphics Printer or Epson FX/MX/RX series dot-matrix printer
- ☐ Houston Instrument DMP-41 pen-and-ink plotter
- ☐ Microsoft Mouse (optional)

The Smart Buy

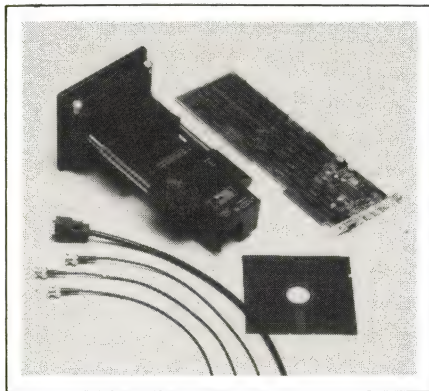
At \$895, smARTWORK® is proven, convenient, fast — *and guaranteed*. Call us today. And put smARTWORK® to work for yourself next week. Try it for 30 days at absolutely no risk. That's smart work.

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1801 South Street
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Telephone: (317) 742-8428
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Woking, Surrey GU21 5JY ENGLAND,
Telephone: 04862-71001, Telex: 859502

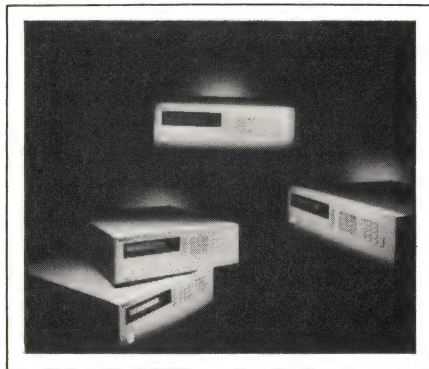
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transmits a video signal to a pc board, which plugs into an IBM PC, for A/D conversion and storage. The board permits the PC to manipulate and analyze data. The instrument can capture repetitive signals at the bandwidth of any analog oscilloscope; it captures transient events as high as two-thirds the analog bandwidth. The camera generates an NTSC standard RS-170 signal. A software package provides waveform graphing and analysis as well as menus. The instrument is compatible with MS-DOS (version 2.1 or greater). \$5395 (without IBM PC). Delivery, four weeks ARO.

Tektronix Inc., Marketing Communications Dept, Box 1700, Beaverton, OR 97005. Phone (800) 547-1512; in OR, (800) 452-1877.

Circle No 412



POWER SUPPLIES

- Family includes four programmable supplies
- 160W in 5¼-in.-high rack

The HP 6621A (two 20V, 80W outputs), HP 6622A (two 50V, 80W outputs), HP 6623A (one 80W and

two 40W outputs), and HP 6624A (four 40W outputs) system power supplies all incorporate several supplies and programmers, a scanner, current-monitor shunts, and a DVM into one package. Each model has 160W in a 5¼-in.-high, full-rack-width package with two, three, or four isolated outputs. The four models offer different combinations of 40

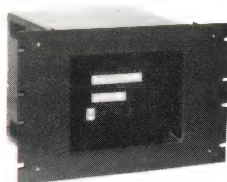
and 80W outputs. Each supply has two full-power output ranges. Consequently, each output of the 6621A is rated at 20V max. And each can source as much as 4A at 20V and source as much as 10A when operating below 7V. Ten registers store preset output values, reducing the number of commands needed for repetitive programming. Appropri-

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Desktop TID



Rack-mount TID



Custom Touch Panel

Coming Soon:
Color Touch and
Flat TID

The **Touch Information Display** (TID) functions as a standard ASCII terminal or PC compatible monitor. Both are available in a rugged metal desktop or rack-mount housing, suitable for both public and industrial environments.

The 12" monochrome **TID Terminal** and **Monitor** communicate through an RS-232 or optional RS-422 port. (Monitor accepts RS-170 composite video input) With the Terminal, an optional feature is 16 pages of downloadable display memory.

Customized touch panels are available for OEM applications.

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For two years, our R&D engineers reviewed everything known about the technology and use of high-power, phase-controlled, dc power supplies, to learn how to make one that would better suit all your applications.

We discovered that many accepted engineering fundamentals needed to be rearranged to improve performance.

The result is our new DCR-T Series. 3-phase input, regulated dc high-power supplies, with unique power ranges that save you money, and performance features simply not available elsewhere. Includes resistive and voltage remote programming of V, I and OVP, and compatibility with Sorensen IEEE programmers. Remote inhibit, OVP shutdown, and current drives for remote meters and all panel indicators are standard. There's even a circuit that senses open remote programming lines and prevents the product under burn-in from becoming a burn-out.

There will be nine 10-kW models of the DCR-T, from 0-8 Vdc to 0-600 Vdc and 16 Adc to 900 Adc. Comparing them with other power supplies is harder than comparing apples and oranges, because the DCR-T is a whole new form of life.

For more information contact:
Sorensen Company, 676 Island Pond Road
Manchester, NH 03103 USA (603) 668-4500

MODEL	Voltage (Vdc)	Current (Adc @ 50° C)
DCR 8-900T	0-8	900
DCR 16-625T	0-16	625
DCR 32-310T	0-32	310
DCR 55-180T	0-55	180
DCR 80-125T	0-80	125
DCR 110-90T	0-110	90
DCR 160-62T	0-160	62
DCR 300-33T	0-300	33
DCR 600-16T	0-600	16

Manufacturer's Suggested List Price \$3,900.

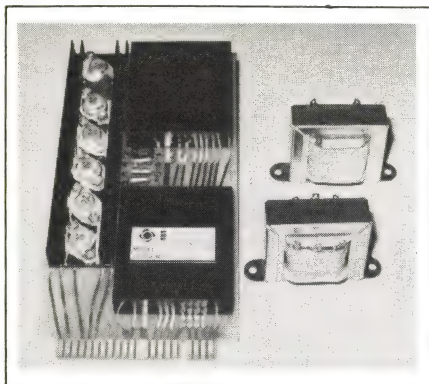


Sorensen
A Raytheon Company

ate connections allow parallel or series operation for increased voltage or current. HP 6621A and 6622A, \$2700; 6623A, \$3200; 6624A, \$3700.

Hewlett-Packard Co., 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 413



SYNCHRO CONVERTERS

- Provides as much as 25 VA
- 14-, 12-, or 10-bit resolution

This series of high-power digital-to-synchro converters with 14-, 12-, or 10-bit resolution can provide as much as 25 VA. The devices can drive torque receivers with an accuracy of ± 10 minutes of arc while maintaining immunity to any overload and transient conditions. These 400-Hz units will accept a 14-bit binary angle and convert it into 3-wire synchro or 4-wire resolver signals. The output is protected against short circuits, thermal overloads, and transients. During any overtemperature condition, the power stages are automatically shut down. A digital fault indicator is also provided. Output voltages are 90 or 11.8V rms line to line (60 or 400 Hz). Digital inputs are TTL compatible; the synchro output is transformer isolated in most models. The devices operate over 0 to 70°C or -55 to +85°C. Less than \$895.

Computer Conversions Corp., 6 Dunton Ct, East Northport, NY 11731. Phone (516) 261-3300. TWX 510-226-0448.

Circle No 414



LAB SUPPLIES

- Provide 80 or 160W ratings
- Offer 0 to 80V outputs

The Model PAR 80A has an 80W output in four voltage ranges: 0 to 8, 16, 35 and 80V. PAR 160, a 160W unit, has ranges of 0 to 16, 35, and 80V. Noise and ripple level for both devices is 300 μ V rms. Transient response is 50 msec. The supplies indicate both current and voltage simultaneously on dual digital displays. The output voltage is controlled with both coarse- and fine-adjustment potentiometers for precise settings. You can program constant current or constant voltage with front-panel controls, or from a control board. The units measure 140 $\times$ 145 $\times$ 350 cm (80A) and 140 $\times$ 145 $\times$ 400 cm (160A). PAR 80A, \$995; PAR 160A, \$1250.

Kikusui International, 17819 S Figueroa, Gardena, CA 90248. Phone (800) 421-5334; in CA and AK, (213) 371-4662.

Circle No 415

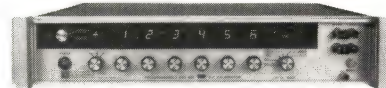
MAC INTERFACE

- Uses PC/AT-compatible expansion cards
- Performs 16-bit transfers

The Macbus mainframe and supporting software provide a programmable I/O processor and allow the use of PC/AT-style expansion cards with a Macintosh Plus personal computer. The Macbus is a μ P-based data-acquisition and instrumentation-control mainframe with

New Instruments

μ P-based Programmable E/I dc Calibrator



Model 520/A

The Model 520/A is micro-processor based and is compatible with IEEE-488, (GP-IP).

The height is only 3½ inches, features current mode outputs from 10 nanoamperes (nA) to 110 milliamperes (mA), in 2 ranges, with extraordinary compliance of 100 Vdc. Even with this power, ideal for transducer instrument testing (4-20 and 10-50 mA), the accuracy is $\pm 0.005\%$!

The voltage mode has 3 ranges with outputs from 100 nV to 110 Vdc and optional to 1100 Vdc. Compliance current is 100 mA. The one year accuracy is $\pm 0.002\%$.

All ranges and both modes resolve to 1 ppm. A crowbar zero provides a reference for this essential value.

Availability: 60 days.

Price: \$2,895. 1000V option \$895.

GSA contract GS00F-86293

Engineering Contact: **Bob Ross**

Tel: (617) 268-9696 CIRCLE NO 184

AC Voltage Reference System Remotely Controlled Multiple Output



System 408

1 to 8 AC Voltage outputs independently and remotely controlled, variable and simultaneous in a single 5¼" high chassis.

A phase angle of 0° and 180° is also programmable.

All functions programmed via **IEEE-488 (GP-IB)** interface bus.

Some applications: Synthesize linear velocity sensors, simultaneous calibration of multiple instrumentation and data logging systems without multiplexing delays. Simulation of transducers. For design, evaluation and calibration of accelerometers, amplifiers, A/D converters, digital and analog meters.

Specifications include: Range: 10 mV to 30 Vac resolved to 1 mV. The compliance current is: 50 mA. The accuracy is: $\pm (0.05\%$ of setting + 15 mV). Output frequency (synchronized to an external sine wave stimulus): at a selected, fixed frequencies between 10 Hz and 400 Hz.

Price: Main frame: \$3,995

Output modules: \$895/each

Engineering Contact: **Bob Ross**

Tel: (617) 268-9696 CIRCLE NO 223

ELECTRONIC DEVELOPMENT CORP.

11 Hamlin St., Boston, MA 02127

Tel: (617) 268-9696

TLX: 951596 (ELECDEVCO BSN)

RCA TLX 240 895 (EDC UR)

five IBM PC/AT-style card slots capable of 16-bit transfers. Two slots are occupied by a μ C card and an SCSI interface, which is the communications link to the Macintosh Plus. The manufacturer's GPIB-V50 μ C card performs real-time data acquisition and instrument control. You can install an optional 8-MHz numeric coprocessor on the

card. The operating system, contained in EPROM on the μ C card, is a version of the manufacturer's IBCL (Instrument Bus Control Language). The software package that runs on the device provides support for the Macbus hardware unit as well as the IBCL operating system and the interactive IBCL programming language. Included in

the software package are the company's IEEE-488 bus Interactive Control utility, an IEEE-488 instrument-configuration utility, and a software driver for communication with the Macbus hardware unit via the SCSI bus. Mainframe, \$1495; software, \$200.

National Instruments, 12109 Technology Blvd, Austin, TX 78727. Phone (800) 531-4742; in TX, (800) 433-3488. TLX 756737.

Circle No 416

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WITH FCC/VDE TESTING AND CERTIFICATION SERVICES

For manufacturers of digital devices selling into world markets, meeting applicable EMI emission and susceptibility standards is an unavoidable reality.

Chomerics Radiation Test Services can locate and measure radiated or conducted EMI, develop a cost-effective fix if necessary, and certify your unit to meet FCC, VDE, CISPR, Part 68, MIL, and TEMPEST standards.

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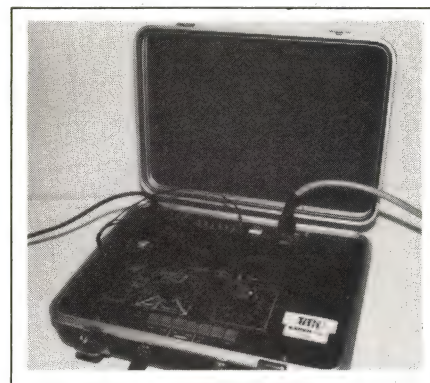
So, if you have an existing product, or are just in the design phase, call Chomerics at (617) 935-4850 ext. 355 and let us help you take on the world.

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ETHERNET TESTER

- Checks Ethernet transceiver
- Offers reflectrometry function

The Experdata E20 Ethernet transceiver tester is a portable tool that also checks all physical elements of an Ethernet local-area network (LAN). You can check for conformance to Ethernet version 1.0, 2.0, or 802.3 standards, measure traffic on the network, and simulate different types of traffic. You can use one tester to check a transceiver before it is installed on a network; all the transmit, receive, and collision-detect functions are tested including the jabber and heartbeat functions as defined in the 802.3 standard. You can also test the transceiver for correct transmit and collision-detect signal levels. In addition, the device provides output connectors for display of transceiver-signal timing on an oscilloscope. You can use two E20s on the network to perform echo tests for verifying frame transmission and reception between two nodes; collision tests to verify re-

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*And shortens the distance
between concept and reality*

Introducing a revolutionary new, multi-function, uniquely expandable, single height 68010 CPU module. The Mizar VME8115. A revolution in its own right. Attached to our unique expansion module, it opens a new frontier in application design. The result—an intelligent VME interface that brings your design concepts to reality faster than ever before.

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mote collision detection; line quality tests to establish a bit error rate for the network; and round-trip delay measurement. The instrument also provides a reflectrometry function to identify the location of cable problems on Ethernet. \$4500.

TITN Inc., 5591 W 78th St, Edina, MN 55435. Phone (612) 944-5440. TLX 298122.

Circle No 417



INTERFACE

- Has an 8000-character data buffer
- For IEEE-488 and Centronics conversions

The Parallel 488 GPIB interface can convert from IEEE-488 to Centronics and from Centronics to IEEE-488. It features an 8000-character data buffer. As a Centronics-to-IEEE-488 converter, the Parallel 488 enables a personal computer to control an IEEE-488 printer or plotter through the computer's parallel printer port. The computer generates data as if a parallel Centronics device were present. The device transfers this data by performing the appropriate IEEE-488 bus addressing and protocol. Alternatively, as an IEEE-488-to-Centronics converter, the device transfers data received from an IEEE-488 controller to a Centronics parallel printer or plotter. \$495.

Iotech, 23400 Aurora Rd, Cleveland, OH 44146. Phone (216) 439-4091.

Circle No 418



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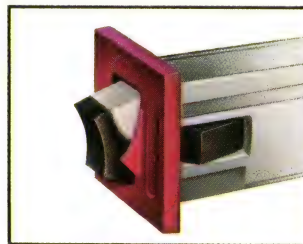
CANTHERM

CIRCLE NO 59

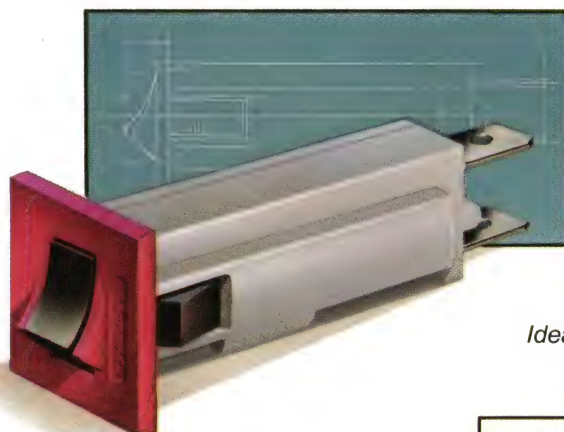


- .250" quick-connect terminals make wiring easy.

- Trip indicator warns of a possible circuit problem. Choice of red or white.



- Special molded clips snap securely into standard $\frac{5}{8}$ " panel cutouts. No redesign or repunching.



- Variety of bezel and button colors permit color coding of circuits. Ideal for convenient up front control panel location.

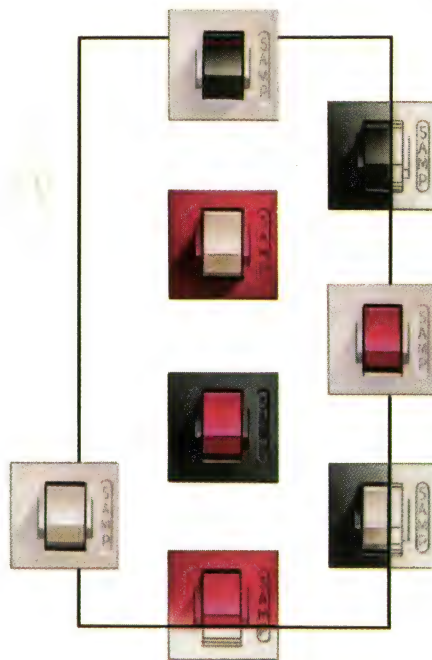
P&B's new snap-in circuit breakers end fuse replacement worries.

Our W28 series thermal circuit breakers fit the same cutout as many $\frac{5}{8}$ " fuseholders. And from 0.25 through 15 amps these UL recognized and CSA certified breakers do the same job as fuses. Only better. When the W28 trips, an indicator pops out to warn of a possible circuit problem. After the trouble is located and corrected, the W28 can be reset by simply pushing a button. But it can't be pulled out to disconnect the circuit.

Easy To Install. Wherever you presently use glass cartridge fuseholders, W28s can replace them without panel redesign or repunching. Think about putting them out front. That way they're easily accessible and their attractive appearance will add to your product's appeal. W28 breakers can be prewired and then snapped securely into the panel from the front.

Helps Sell Your Product. For everything from home entertainment equipment to medical instruments to industrial test gear, W28 breakers add selling points to your product. Good looks. The convenience of not searching for fuses. Protection against improper fuse rating substitutions. And they save the cost and trouble of maintaining a fuse inventory.

Write For Our Catalog. Find out about the economical W28 and our full line of magnetic and thermal circuit breakers. They're available off-the-shelf from authorized P&B distributors backed by our sizable factory inventory. Or contact your local P&B sales representative. Potter & Brumfield Inc., 200 South Richland Creek Drive, Princeton, Indiana 47671-0001. Call toll free 800/255-2550.



8609

Potter & Brumfield A Siemens Company

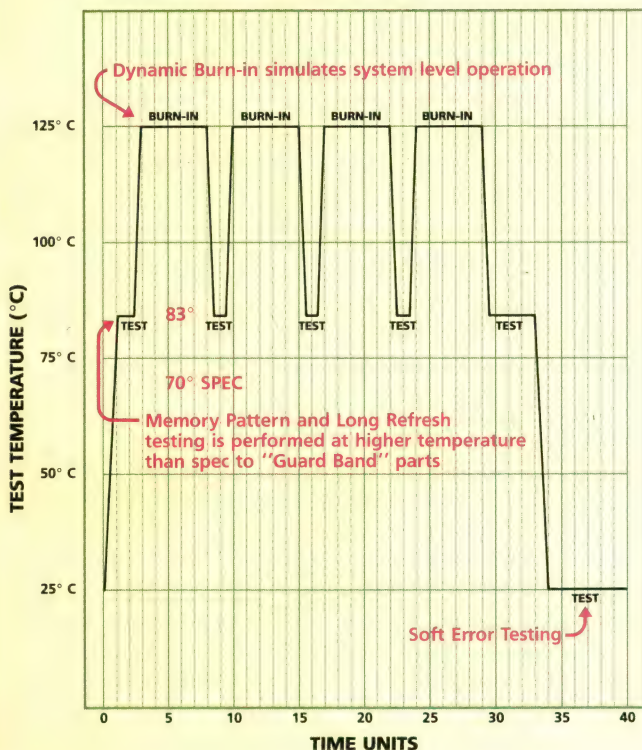
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Talk Is Cheap

We don't just talk about quality at Micron Technology. Since 1984 we've instituted specific verifiable improvements in production procedures, test systems and product tracking that make Micron DRAMs stand above the competition.

AMBYX™ BURN-IN/TEST FLOW

(Example)



Fabrication And Assembly

Micron parts are now produced on DESC-certified Class 10 fab lines, meeting high military standards. Large production capacity and auto-

mated on-site assembly ensure Micron's ability to fill fast-turnaround customer orders without compromise in production quality.

Test And Burn-In

Micron's on-site test program is the most stringent in the industry. Our development in 1985 of the AMBYX™ Test and Burn-In System allows large-scale monitored burn-in with simulated system level operation. The AMBYX™ System also provides extended system level soft error testing, extended test time for data retention and temperature ramp testing for package defects. You just won't find a more verifiable test program.

Product Tracking

In 1985 Micron set up a QA Quarantine Program to guarantee that each lot passes environmental and electrical testing as well as burn-in before any part is shipped. To keep track of product identity all the way to the end user we now laser mark the lot code on each part. This procedure yields complete accountability through process steps, machines, even individual operators.

PRODUCT
QUARANTINE
AREA

Customer Service

Quality doesn't end with a good product. Micron supports a worldwide network of knowledgeable representatives, and our engineering staff backs them up with responsive application assistance.

At Micron we've worked hard to give quality a real meaning, in our products and in our service. We'll continue working to provide the real quality you need.

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CIRCLE NO 187

NEW PRODUCTS

INTERNATIONAL



MIL-STD RELAYS

- Meets MIL-R-6106J specs
- Available for 10A, 28V dc or 115V ac, 400 Hz

Measuring 20.6×10.4×16.3 mm and weighing 16g each, M215 Series relays have a single-pole changeover contact with a resistive-load contact rating of 10A at 28V dc or 115V ac, at 400 Hz. The relays also handle fault currents as high as 150A for 0.53 sec. The relays meet MIL-R-6106J requirements, and versions are available with nominal coil-operating voltages of 6, 12, or 28V. The 28V coil version is also available with voltage-spike suppression as high as ±42V. When the relays op-

erate at their nominal coil voltages, their operate-and-release time is 6 msec; the maximum contact-bounce time is 1 msec. The minimum lifetime at full-rated resistive load is 50,000 operating cycles, but by de-rating to 25% of rated load you can achieve a lifetime of 200,000 cycles. The operating-temperature range is -70 to +125°C. The relays are compatible with 10A thermal circuit breakers and are available in established-reliability or high-reliability versions. DM 200.

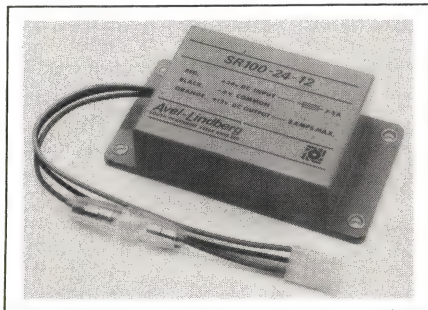
LRE Relais & Elektronik GmbH, Linprunstrasse 16, 8000 Munich 2, West Germany. Phone (089) 523020. TLX 522190.

Circle No 419

REGULATOR

- Accepts 18 to 30V inputs
- Provides 12 or 13.8V, 8A output

Designed to supply power to electronic equipment in mobile vehicles, the SR100-24/12 switching regulator accepts an input voltage in the range of 18 to 30V dc and provides a regulated 12 or 13.8V dc output. The output has a maximum continuous-current capability of 8A and a power rating of 100W. Overall efficiency of the regulator is between 80% and 90%. The output features overvoltage protection (at 15V typ) and current limiting (at 130% typ). A 7.5A in-line fuse in the positive line protects the input, and a non-reversible plug with input, output,



and common-negative line functions makes connections. Input ripple is <50 mV and output ripple is <20 mV. The output regulation for full-line and load variations is <1%. £48 (100).

Avel-Lindberg Ltd, South Ockendon, Essex RM15 5TD, UK. Phone (0708) 853444. TLX 897106.

Circle No 420

IEEE-488 CONTROLLER

- Runs OS9 operating system
- Accommodates 20 prioritized tasks

Designed around an 8-MHz 68000-based CPU card, the Condor 68 IEEE-488 system controller runs the OS9 real-time, multitasking operating system and accommodates as many as 20 prioritized tasks. The controller can function as an IEEE-488 talker/listener, device-addressing, and interface-command unit, and it includes serial- and parallel-poll capabilities. You can call a library of control routines for the IEEE-488 interface from any of the controller's programming languages. Six RS-232C/RS-422 interfaces allow you to connect operator terminals, or to network the controller with a host computer. The unit incorporates 512k bytes of RAM (expandable to 896k bytes) and two 1M-byte, 3½-in. floppy-disk drives. You can replace one of the floppy-disk drives with a 10M-byte Winchester drive. Additional I/O ports include a Centronics-compatible parallel port and a general-purpose, 8-bit bidirectional I/O port. Internally, you can expand the controller's capabilities with single-Eurocard plug-in boards. Available plug-in boards include additional memory cards, extra IEEE-488 interface cards, a PROM-programmer card, and a high-resolution monochrome or color graphics card. Standard software includes the OS9/68K operating system and the Basic-09 programming language. The Testmatch, Pascal, and C languages are available as options. £6350.

PPM Instrumentation Ltd, Hermitage Rd, St Johns, Woking, Surrey GU21 1TZ. Phone (04867) 80111. TLX 859181.

Circle No 421

CAE/CAD SOFTWARE

- *Runs on IBM PC/XT and PC/AT*
- *Lets you design multilayer pc boards*

Previously available only for use on Prime or DEC minicomputers, the Hyboard pc-board CAE/CAD package now runs on an IBM PC/XT or PC/AT equipped with 640k bytes of RAM, a hard disk, and a math co-

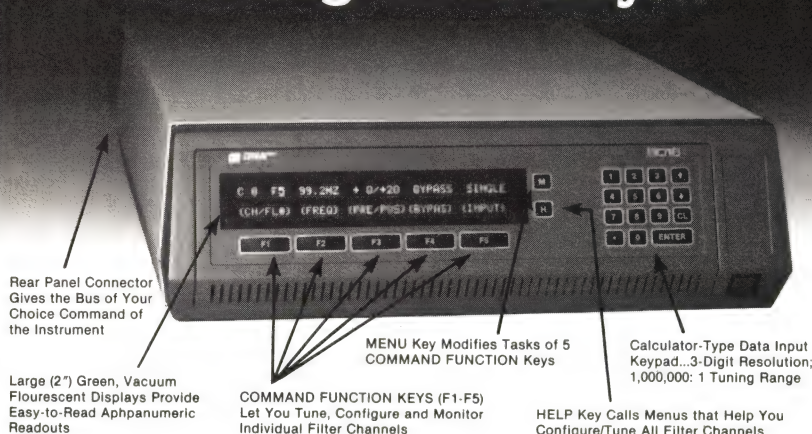
processor. The two basic software modules, Hyboard-CCT and Hyboard-PCB, allow you to produce circuit schematics and pc-board layouts, respectively. With the Hyboard-CCT module, you can create schematic drawings using predefined symbols and logic components. The program can produce the drawing on a single sheet or

divide it into logical sections for drawing on multiple sheets. You can also predefine component macros, which you can store and recall for use on any circuit schematic. Hyboard-PCB takes the net-list output from Hyboard-CCT and allows you to lay out a multilayer pc board as large as 640 mm² and having as many as eight layers. You can generate tracks of varying widths and use standard or user-defined pad layouts. Track copy, parallel-track generation, component space checking, automatic via generation, and design-rule-check functions are also included. An optional software module, Hyboard-AR, allows you to perform fully automatic or interactive track routing. End-user license, Hyboard-CCT, £2000; Hyboard-PCB, £2000; Hyboard-AR £1000.

The Hytech Group, Chequers Parade, Wycombe Rd, Prestwood, Bucks HP16 0PN, UK. Phone (02406) 6071. TLX 83686.

Circle No 422

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CIRCLE NO 60

CPU CARD

- Uses 68010 μ P in VME Bus system
- Runs at 10 or 12.5 MHz

The TSVME-104 double-Eurocard CPU board for VME Bus systems has a 68010 μ P running at 10 or 12.5 MHz with a 68881 math coprocessor. Onboard memory comprises 512k bytes of zero-wait-state, parity-checked dual-port RAM, and sockets for as much as 128k bytes of EPROM firmware. Additional on-board functions include a real-time clock, four RS-232C serial interfaces, a 7-level interrupt handler and interrupt generator, and a single-level bus arbiter. The CPU is capable of operating as part of a multiprocessing system, and it has a local bus-extension connector that allows you to add a range of functional modules, including battery-backed CMOS RAM, additional firmware memory, and a SCSI, Centronics, or parallel TTL inter-

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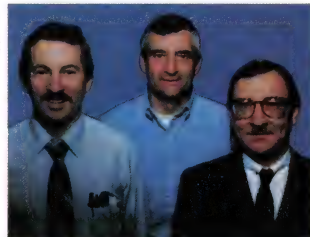
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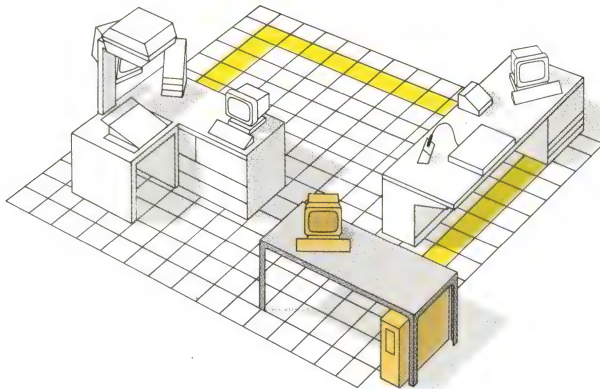
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face. The TSVME-105, a similar CPU card without the math coprocessor, is also available. TSVME-104, Fr fr 23,256; TSVME-105, Fr fr 18,860.

Thomson Semiconducteurs, 45 Ave de l'Europe, 78140 Velizy, France. Phone (3) 9469719. TLX 204780.

Circle No 423

Thomson Semiconductors, VSI, 761 E University, Mesa, AZ 85203. Phone (602) 962-9579.

Circle No 424

DISASSEMBLER

- Works with PM Series logic analyzers
- Translates μ P-bus traffic to assembly language

You can use this disassembler for the 80286 μ P with the company's PM 3551A, 3565, and 3570 logic analyzers. It translates captured μ P-bus traffic into assembly-language mnemonics along with all relevant operands, addresses, and addressing modes. The disassembler automatically filters out instructions that are prefetched (but not executed) by the μ P's pipelined instruction architecture, and it aligns data moves with the instructions that prompt them. The PROM-based disassembler resides on an option board within the logic analyzer, where it can coexist with three other disassemblers. A special probe for the logic analyzer allows you to connect the board directly to the 80286's 68-pin grid-array socket. PROM-based disassembler, Gld 3000; analyzer front-end hardware, Gld 3950.

Philips, Industrial & Electroacoustic Systems Div, Box 523, 5600 AM Eindhoven, The Netherlands. Phone (040) 757005. TLX 51573.

Circle No 425

Philips Test & Measurement Inc, 85 McKee Dr, Mahwah, NJ 07430. Phone (201) 529-3800.

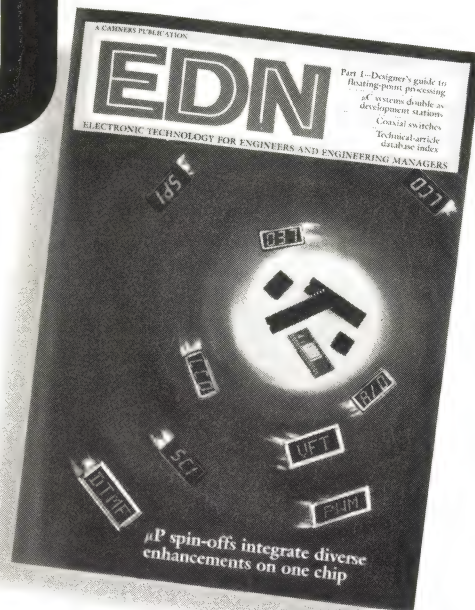
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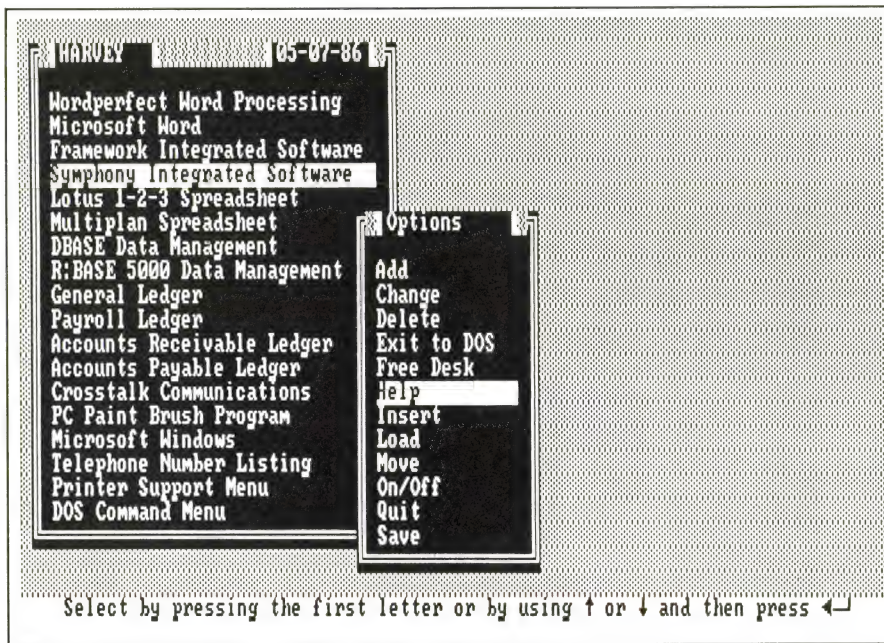


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NEW PRODUCTS

SOFTWARE



MENU EDITOR

- Replaces DOS prompt with systems of menus
- Lets you create, save, and change menus

Offering an alternative way to call up DOS commands on an IBM PC, PC/XT, or compatible computer, the FirstMenu program replaces the DOS prompt with a system of menus. You can create, save, or change menus to run applications, perform DOS operations, or select other menus. The program is compatible with the Microsoft mouse. You can create any number of menus, each having as many as 20 selections, and an entry on one menu can call up a submenu. You can also color-code menus and select background and foreground colors. Because the software is not copy-protected, you can add a menu to any of your system disks. An index that's keyed to the on-screen help menu lets you look up specific information with two or three keystrokes. The program also includes a paging function. The utility occupies 15k bytes of RAM; to make

effective use of the program, you need at least 192k bytes of RAM. \$39.95.

Harvey, Box 1863, Cape Coral, FL 33910. Phone (800) 231-0296; in FL, (813) 482-8600.

Circle No 427

ADA COMPILER

- Compiled programs can use full 16M-byte address space of 80286
- Run-time executive supports multitasking

An application compiled with the Alslys PC/AT Compiler can run in virtual mode; as a result, the software can directly access as much as 16M bytes of memory on an IBM PC/AT or a compatible computer. Using this compiler, you can avoid dividing a large application into overlays, and you can avoid processing delays caused by moving blocks of the overlaid code to and from memory as well. The conversion tool translates each compilation unit into object code for the 8086 μ P family. The program's library manager can create, delete, copy, and rename the Ada program library.

Its unit manager examines and maintains individual units in the Ada program library, and its binder checks and combines separately compiled units into a single object program. The run-time executive is a set of routines that allocates memory for data storage while an Ada program is running; manages exception handling; and controls tasking. The price includes a 4M-byte memory board. \$2995.

Alslys Inc, 1432 Main St, Waltham, MA 02154. Phone (617) 890-0030. TLX 948536.

Circle No 428

COMM PROGRAM

- Transfers files while you work on an applications program
- Command files execute complex operations

Besides providing basic communications features, the Backcomm Version 1.2 program can encrypt and decrypt files, and compress and expand files, without leaving the program. The program also features password protection; automatic call scheduling by day, date, and time; and Backtalk, the company's built-in command language. This language provides arithmetic, evaluations, decision-making capabilities, file read/write, screen formatting, and an interface to other programs that are executing simultaneously. The background mode allows the program to run while you work on another application program in the foreground. The context-sensitive help screen eases the transition from menu-driven to command-driven operation. The help function also offers a table of contents and an indexer. \$95.

LaSalle Micro Inc, 1350 Remington Rd, Suite W, Schaumburg, IL 60195. Phone (800) 882-5171; in IL, (312) 882-5171.

Circle No 429

TELECOMM

- Provides shortcut for executing Autopilot sequence
- Lets you put automatic startup sequence on any document

Smartcom II version 2.2 is an upgrade of this company's communications software for the Apple Macintosh. The upgrade provides Option

Key Autopilot sequences, Autostartup sequences, and the ability to rename files. It also supports the Macintosh Plus and the hierarchical file system (HFS), which improves file handling and organization, and it's compatible with all earlier models of the Macintosh. The Option Key Autopilot sequence shortens the execution of an

Autopilot sequence. It lets you assign a single-character identifier to an Autopilot sequence; to execute the sequence, you just press the identifier key and an option key. Each document can contain an Autostartup sequence. This feature allows you to switch into the communications program, dial, log onto another system, execute the Autopilot sequences, and log off, all with two strokes of the mouse, according to the manufacturer. The upgrade retains all the features of the original program release, including interactive graphics, context-sensitive help messages, terminal emulation, multiple protocols, and voice/data transmission. The software provides for data transmission at 19,200; 9600; 2400; 1200; or 0 to 300 bps. \$149.

Hayes Microcomputer Products Inc., Box 105203, Atlanta, GA 30348. Phone (404) 449-8791.

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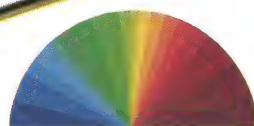
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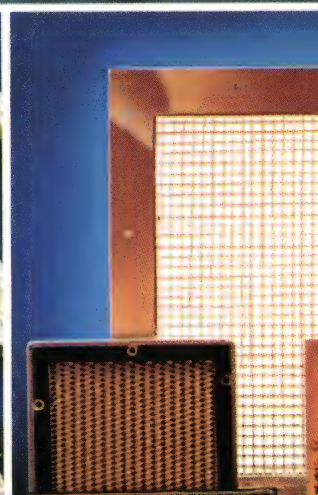
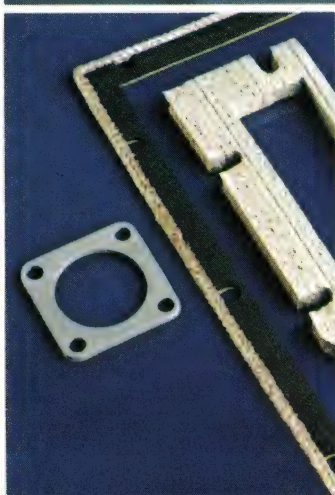
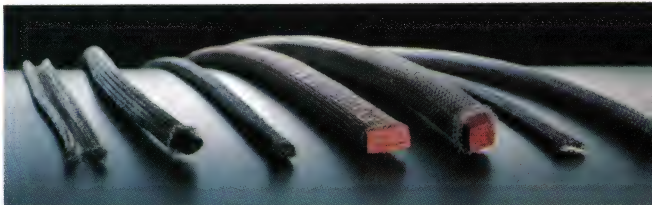
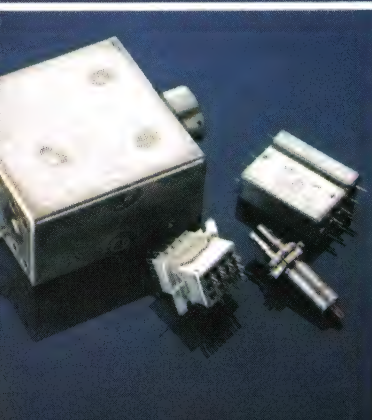
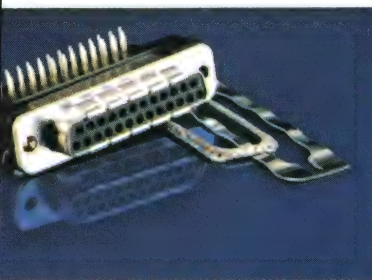


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CIRCLE NO 233

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SOFTWARE

and network I/O—to its concurrently running processes. The Histogram Program Counter tool displays the execution time of each line of code within a given procedure so that you can identify code that consumes excessive time or is not used at all. \$250 per node; \$980 per site.

Apollo Computer Inc., 330 Billerica Rd, Chelmsford, MA 01824. Phone (617) 256-6600. TWX 710-343-C803.

Circle No 431

PASCAL COMPILER

- *Conforms to ISO standard*
- *Performs extensive error checking*

This compiler, which runs on the vendor's VME-based Unix V Microforce computers, generates fast and compact code. It conforms to the ISO-dp 7185.1 standard. Compile- and run-time error-checking aid in

maintaining application programs. Other features include a source-level interactive debugger; a profiler that identifies program bottlenecks; a source-code and text formatter that speeds up source-code entry; and a cross-reference generator and dynamic string library. License fee, \$600.

Force Computers Inc., 727 University Ave, Los Gatos, CA 95030. Phone (408) 354-3410.

Circle No 432

REAL-TIME KERNEL

- *Supports as many as 255 concurrent tasks*
- *Can reside in 4k bytes of ROM*

Quick-Task is a real-time executive kernel for use in HD64180- or Z80/NSC800-based embedded computing applications, such as process control, data acquisition, and robotics. It features full source code; no

run-time fees; and multiprocess communication, boxes, and queues. Its *Exitrdy* command suspends a completed task and reschedules it for completion. This command prevents degradation of overall system performance by tasks such as servicing slow I/O devices. Other features include multiprocess synchronization, round-robin or priority-based scheduling, and support for as many as 255 tasks concurrently. The program's code segment is small—4k bytes—and can therefore be resident in ROM. The software also furnishes hardware-interrupt support. \$249.

Echelon Inc., 885 N San Antonio Rd, Los Altos, CA 94022. Phone (415) 948-3820.

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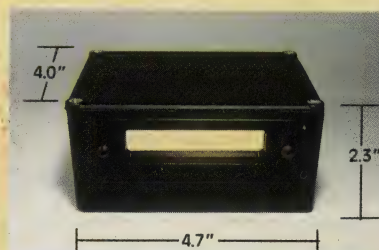
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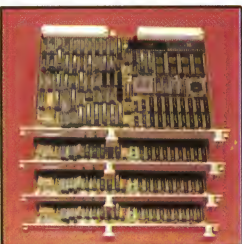
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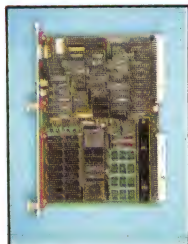
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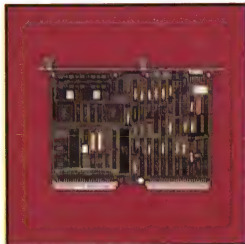
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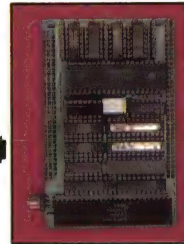
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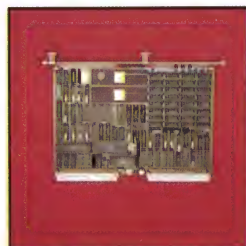


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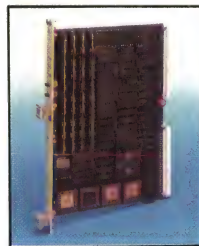
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CPU-4RT

STAND ALONE HOST



CPU-1



CPU-3

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MICROPROCESSOR	68000/68010	68010	68000/68010	68000/68010	68000/68010	68020
FREQUENCY	8MHz	12.5 MHz	12.5 MHz	12.5 MHz	12.5 MHz	12.5 - 20 MHz
MEMORY MANAGEMENT	68451	68451 (2nd as option)				
DMA	LOGIC		68450 option	68450 option	68450 option	
FLOATING POINT PROCESSOR		68881 (option)			68881 (option)	68881 (option)
RAM (DUAL PORTED)	256 Kb	2 Mb	128/512 Kb	128/512 Kb	512 Kb	1/4, 1, 4 Mb
EPROM		2 Sockets (128 Kb)	2 Sockets (128 Kb)	2 Sockets (128 Kb)	2 Sockets (128 Kb)	2 Sockets (128 Kb)
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SIO	1 PORT	1 PORT	2 PORTS	4 PORTS	• I/O ON PIGGYBACK BOARDS • PB-SCSI1 SCSI/DMA • PROTO BD	3 PORTS
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TIMERS	1	4/ 8 bit	3/ 16 bit			1/ 32 bit
ADDITIONAL FEATURES	1K PROM FLOPPY DISK CONTROLLER	Translation Cache	R/T CLOCK 58274	R/T CLOCK 58274		
SOFTWARE	UNIX* SYS V	UNIX* SYS V pSOS**	pSOS** PDOS***	pSOS**	pSOS**	pSOS** PDOS***

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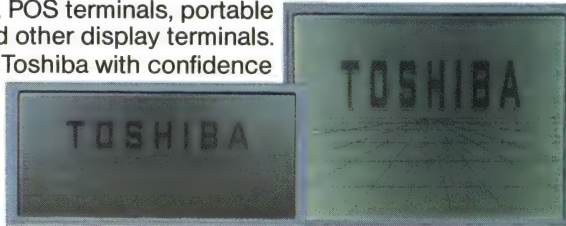
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TLC-363

TLC-402

Specifications

	TLC-402	TLC-363B
Display		
Number of Characters	80 $\times$ 25 (2,000 characters)	80 $\times$ 25 (2,000 characters)
Dot Format	8 $\times$ 8, alpha-numeric	8 $\times$ 8, alpha-numeric
Overall Dimensions (W $\times$ H $\times$ D)	274.8 $\times$ 240.6 $\times$ 17.0 mm	275.0 $\times$ 126.0 $\times$ 15.0 mm
Maximum Ratings		
Storage Temperature	-20 $^{\circ}$ ~ 70 $^{\circ}$ C	-20 $^{\circ}$ ~ 70 $^{\circ}$ C
Operating Temperature	0 $^{\circ}$ ~ 50 $^{\circ}$ C	0 $^{\circ}$ ~ 50 $^{\circ}$ C
Supply Voltage	VDD 7 V VDD - VEE 20 V	7 V 20 V
Input Voltage	0 $\leq$ VIN $\leq$ VDD	VSS $\leq$ VIN $\leq$ VDD
Recommended Operating Conditions		
Supply Voltage	VDD 5 $\pm$ 0.25V VEE -11 $\pm$ 3V Var.	5 $\pm$ 0.25V -11 $\pm$ 3V Var.
Input Voltage	High VDD - 0.5V min. Low 0.5V max.	VDD - 0.5V min. 0.5V max.
Typical Characteristics (25°C)		
Response Time	Turn ON 300 ms Turn OFF 300 ms	300 ms 300 ms
Contrast Ratio	3	3
Viewing Angle	15 - 35 degrees	15 - 35 degrees

Design and specifications are subject to change without notice.

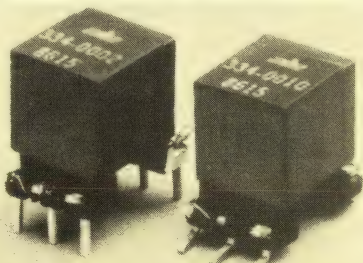
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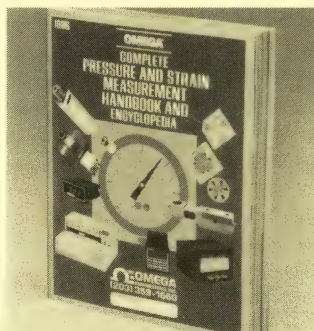


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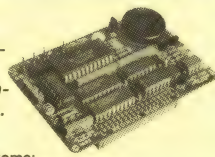
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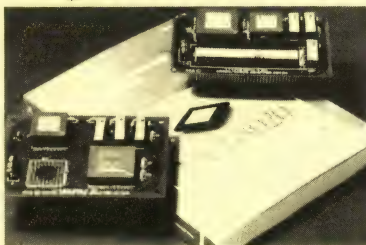
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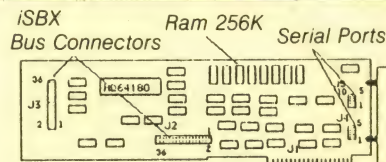


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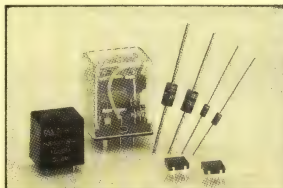
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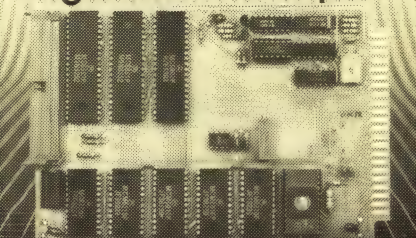
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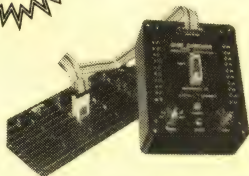
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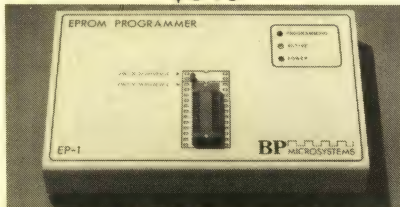
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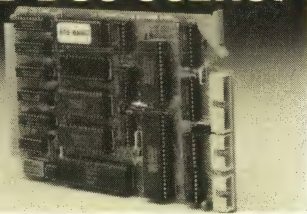
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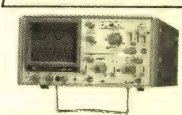
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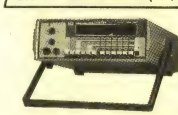


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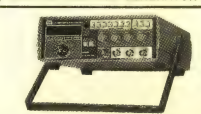
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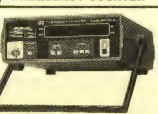
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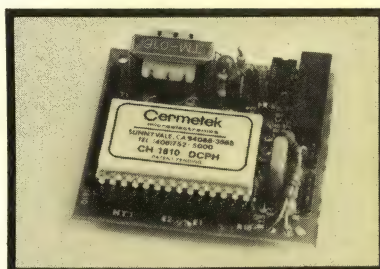


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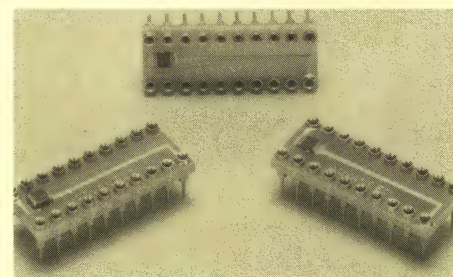


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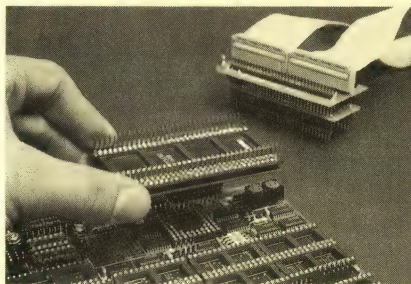
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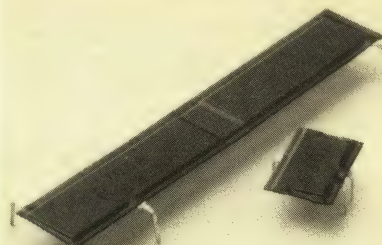
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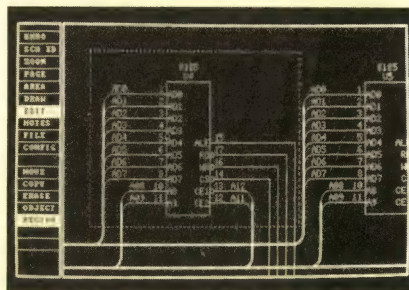
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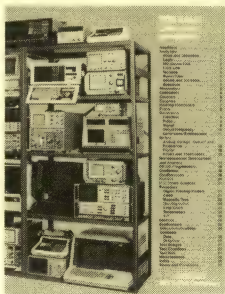
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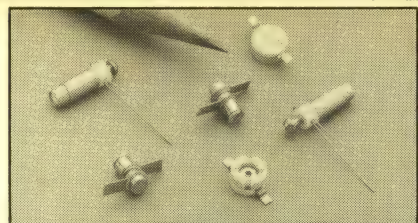
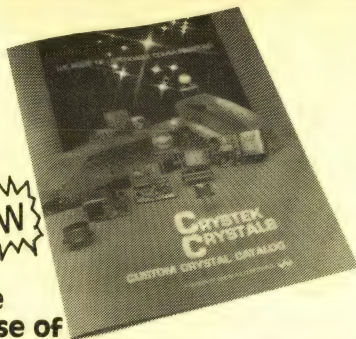
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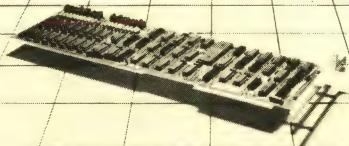
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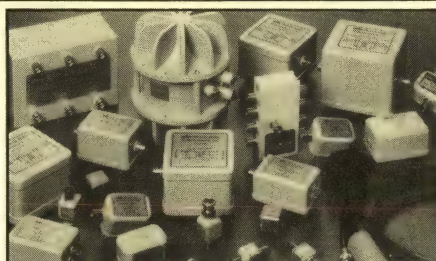
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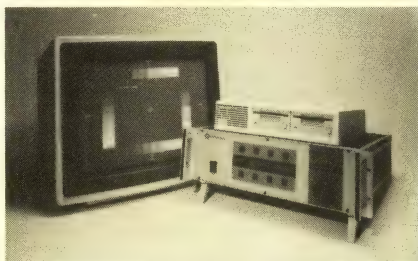
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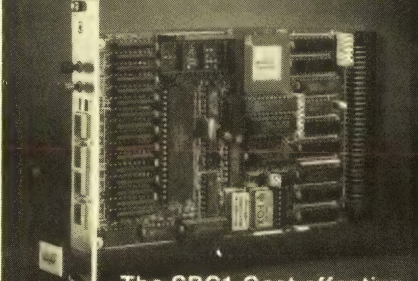
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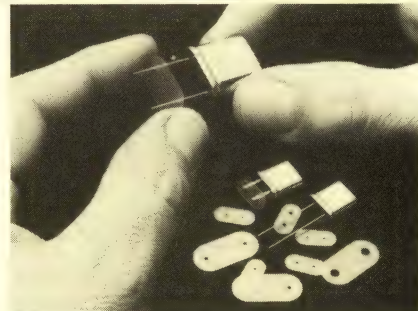
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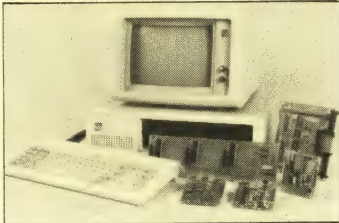
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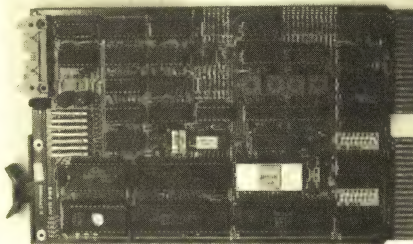


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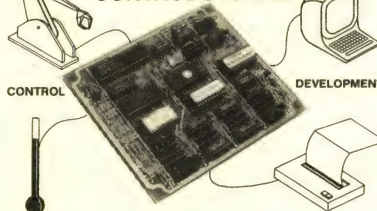


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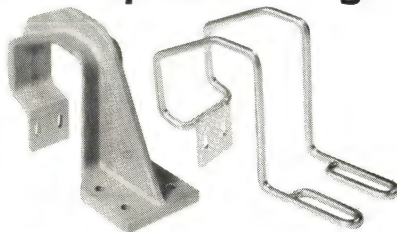
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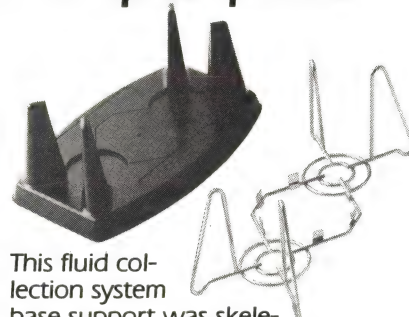
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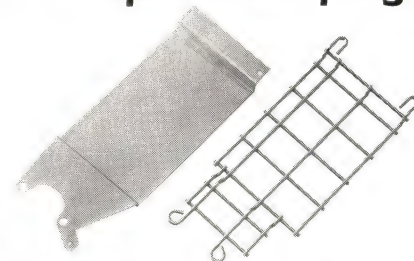
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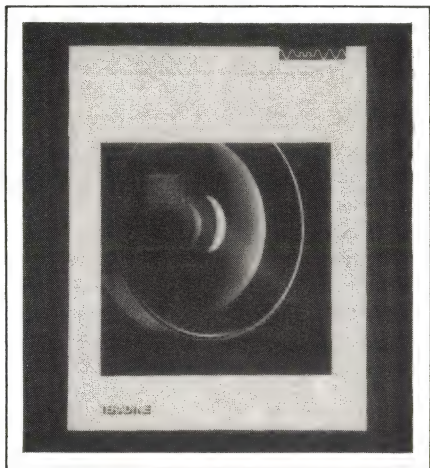
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Brochure describes solution for testing image sensors

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These parameters include dark-level measurements, defect counting (pixel defects and black-and-white poles), bloom level, and blotch and smear defects. The brochure then describes how the system accomplishes these tests. Finally, it highlights the test system's features and introduces other instrument modules from the manufacturer.

Teradyne Inc., c/o Inquiry Systems & Analysis, 25 Drydock Ave, Boston, MA 02210.

Circle No 381

Book categorizes ASICs

Semicustom Databook For CMOS Gate Arrays And Standard Cells, a 220-pg publication, catalogs the macrocell libraries available for designing IGC20000 Series gate arrays and ISC20000 Series standard cells. Divided into seven sections, the book provides an overview of the manufacturer's ASICs (applica-

tion-specific integrated circuits), including data such as characteristics, descriptions of workstation support and the company's CAD system, and a process summary for converting gate arrays to standard cells. In addition, it describes all internal macrocells, I/O macrocells, Flexicells, and ISC20000 megacells in the series' libraries (including RAM, ROM, and GE2900 Series microprocessor functions).

GE Semiconductor, 318 First St, Liverpool, NY 13088.

Circle No 382

Manual for DSP

A DSP user's manual, *DSP56000-UM/AD*, and a condensed technical summary, *BR282*, help you understand the architecture of the DSP56000 DSP chip. The manual includes chapters on signal description, data organization and addressing modes, the instruction set, the



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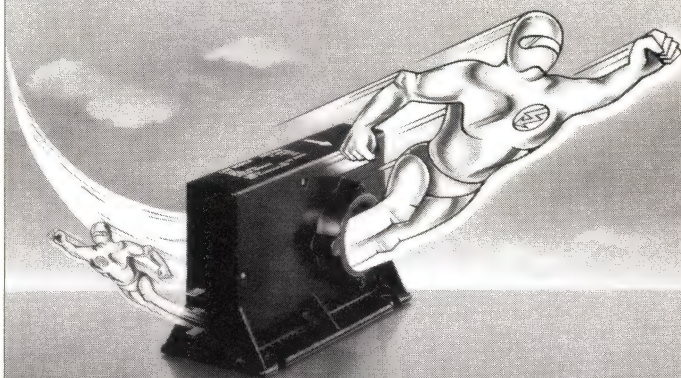
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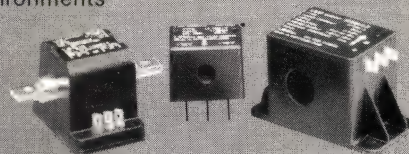
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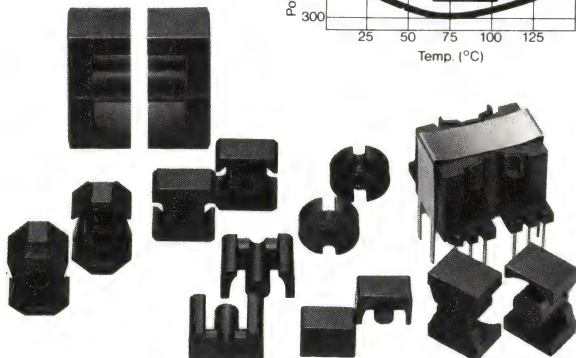
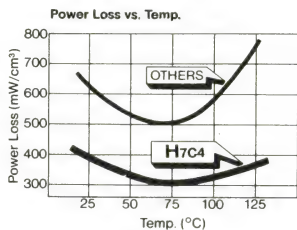
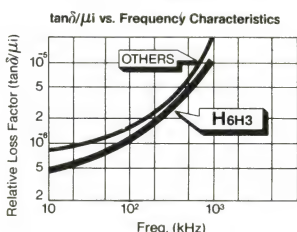
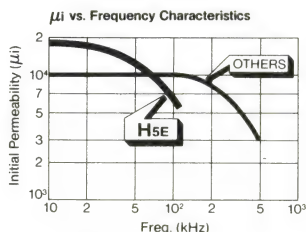
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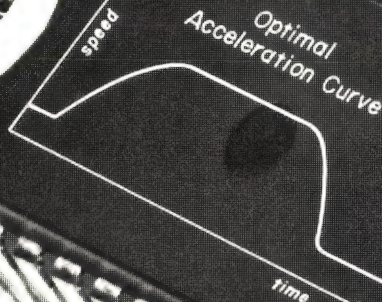


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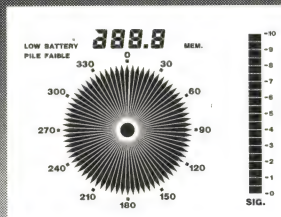


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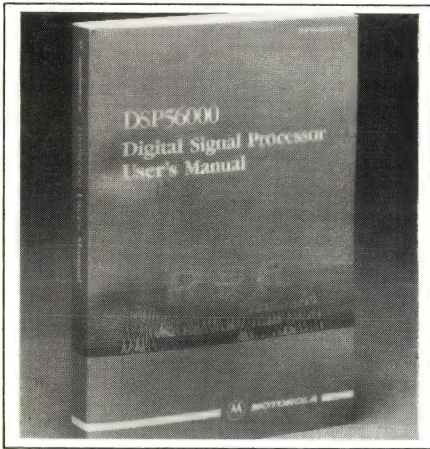
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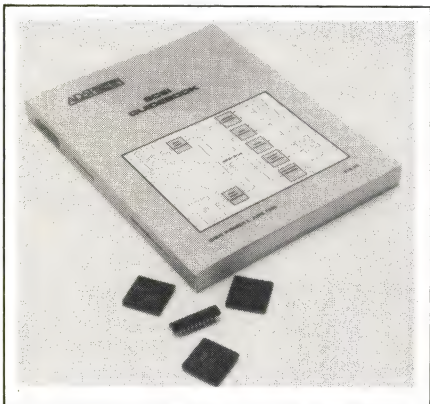




I/O interface, exception processing, and chip operating modes. Appendices A and B cover instruction-set details and the chip's benchmarks, respectively. The manual costs \$8.65; the technical summary is free.

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Data book answers questions pertaining to T-1 networks

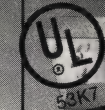
DACS and D4 Compatibility answers technical questions related to the issue of equipment compatibility when building networks linked by T-1 transmission facilities. The 8-pg brochure discusses T-1 framing, D3/D4 formats, and DACS (digital access and cross-connect system),

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CIRCLE NO 66

Remember to vote in the IEEE election

Ballots for the Institute of Electrical and Electronics Engineers' (IEEE) annual election for 1987 president-elect, executive vice president, and regional and divisional directors will be mailed to all members by September 1. The IEEE's board of directors has nominated 28 candidates for election based on recommendations from regional and divisional nominating committees. Ballots must be returned to IEEE headquarters by November 3. Election results will be announced on November 13.

The position of president is a 2-year term; the winning candidate serves the first year as president-elect and the second year as president. Two candidates, Russell Drew and Merlin Smith, have been nominated by the board of directors. The third candidate, Irwin Feerst, earned a place on the ballot by submitting a nominating petition signed by 2260 IEEE members. Profiles of the three candidates for president-elect follow. —*Deborah Asbrand*

president by the organization's board of directors. "If you go to an IEEE meeting, you'll often meet engineers there that are disillusioned and disappointed that their roles aren't considered as important as they think they should be."

Smith is manager of systems technology for IBM's Thomas Watson Research Center in Yorktown Heights, NY. He is responsible for exploring new applications of LSI systems. He previously worked in LSI development and managed projects in packaging and in the design of circuits and chips. He has worked for IBM since 1952, the year he began his engineering career.

Smith's involvement with the IEEE began in 1957 when he became involved in the organization's technical activities. He is a member of the IEEE Computer Society and served as its president in 1977 and 1978. He was elected to the position of executive vice president in 1985. Smith is currently vice president for technical activities. He has attended meetings of the Boston chapter for the last four years.

"We have established a reputation in the IEEE, and we must build on that and remind our employers that we're out there and that we can really do something for employers," he says. "We set the stage for the exchange of information. Our recognition programs are of benefit to all of them. But we must also build our image and our reputation with them."

Although he's pleased with the IEEE's work in disseminating technical information, Smith wants the IEEE to take a more active role as a technological leader. "We're in a changing environment," he says. "One of the things I'm working on now is to make sure the Institute isn't just following technology."

Merlin Smith:

Focusing attention on engineering accomplishments



Jonathan Levine

"I'd like to get us in a better position of predicting technology's future."

Enhancing the image of engineers is an obligation of the IEEE, says Merlin Smith. Although the IEEE's recognition awards and its memberships forums "let the world know we're doing good things in those areas," says Smith, he favors devoting more of

the IEEE's money and resources to increasing public awareness of engineering accomplishments and engineers' roles in society.

"We have a membership clamoring for greater recognition of their importance," says Smith, who was nominated for the position of IEEE

PROFESSIONAL ISSUES

Right now, we're reactive to things that happen. Our members are more involved in presenting technology [through conference papers] than anticipating where technology will lead. I'd like to get us in a better position of predicting technology's future."

To keep fresh ideas flowing into the IEEE organization, Smith would like to expand its base of volunteers. Smith says he sees too many instances where one person fills several posts within the organization, resulting in a small cluster of active volunteers. To bring more people in, he suggests limiting vol-

unteers to one position and creating more volunteer functions.

Continuing education of engineers, says Smith, is an area in which the IEEE should become more of a leader. "Some of even the largest companies are finding that it's difficult to [implement] continuing education [programs] by themselves. We need industry-wide and Institute-wide objectives in which the IEEE tries to act as an honest broker in pulling together and sharing materials.

"The people that make up the IEEE can help us identify what their needs are in continuing educa-

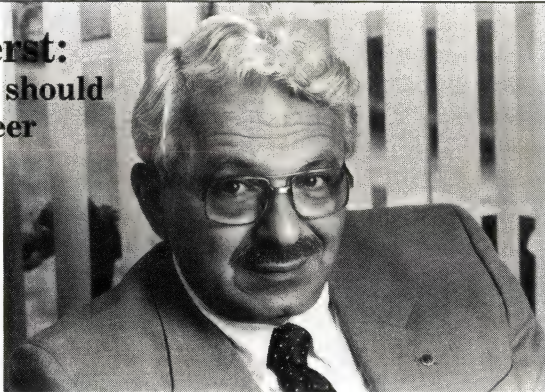
tion. They can identify new [teaching] techniques and materials that are being used."

Smith credits the autonomy of the IEEE's subsections with having helped the organization reach what he calls "preeminence." But he also eyes the same autonomy as being partially responsible for the organization's difficulty in accomplishing broader objectives like better support for continuing-education programs. Despite this qualification, Smith wants to extend greater autonomy to the sections so that they may "continue the good things they've been doing."

Irwin Feerst: The last E in IEEE should stand for engineer

*"What I want to do
is make an engineer*

a professional in every sense of the word."



Jonathan Levine

cerned EEs. "I thought it was important to formalize the complaints I'd made as an IEEE member," he says. "It occurred to me that a more formal method of doing that would also give voice to the other people who had complaints and might be more effective than 'individual noise sources.'" Feerst mails his monthly newsletter to more than 3000 recipients. The organization has no dues-paying members, only individual supporters. Supporters contributed \$22,210 to the organization in 1984.

Feerst has few complaints about the IEEE's technical activities. The IEEE's technical publications, however, he targets for reform. Feerst views with disdain the specialized journals published by the IEEE's technical societies. He sees these narrowly focused periodicals not as centers of practical application information, but as forums for academicians who must "publish or perish." To prevent the technical articles from becoming too theoretical, he advocates adding more practicing engineers to publications review boards. He also favors placing a "criterion of utility" on technical papers that would ensure that the material would have practical applications.

Feerst's most energetic plans for the IEEE lie in the area of profes-

For Irwin Feerst, election to the post of IEEE president would mean an opportunity to awaken not only the IEEE, which he considers a sleeping giant, but also the whole electrical engineering profession. Feerst attributes electrical engineers' low professional profile to what he considers to be the IEEE's lack of attention to engineers' career concerns. Reshape the organization's goals so that they better represent members' concerns, he reasons, and members will take a more active role.

Feerst earned a place on the IEEE ballot by gathering signatures from more than 2000 IEEE members. He has been a member of the organization since 1948 and its most vocal critic for nearly as long. Feerst spent the early years of his

career working for what he calls "profit-minded organizations." In 1962, he turned to teaching and taught physics and electronics at Adelphi University for seven years. Since 1969, he has worked as an independent consulting engineer for electronic countermeasures and medical electronics on New York's Long Island.

At the same time that he was preparing to leave teaching, Feerst was growing increasingly opposed to the direction in which he saw the IEEE heading. The IEEE was becoming "less responsive to the needs of working engineers and more responsive to the needs of academicians and corporate executives. That's when I decided to grab the tiger by the tail." In 1973, he founded the Committee of Con-

PROFESSIONAL ISSUES

sional activities. It's in matters of employment opportunity, pension reform, age discrimination, and professional support that Feerst sees the IEEE as having failed its membership most. "Engineers are encouraged [by employers] not to think further along than the next design problem," Feerst says. He supports devoting more space in the IEEE's *Institute* and *Spectrum*, its monthly newspaper and magazine, to professional issues. "I'd like to see articles on ways of raising venture capital for a new business; I'd like to see a listing of courses other than those sponsored by the IEEE, and I'd like members to know more about the inner workings of the IEEE. What I want to do is make an engineer a professional in every sense of the word."

His vision for the IEEE includes having the organization take an active role as member advocate. He sees age discrimination as a serious threat to engineers and an area in which the IEEE should assist members with grievances against their

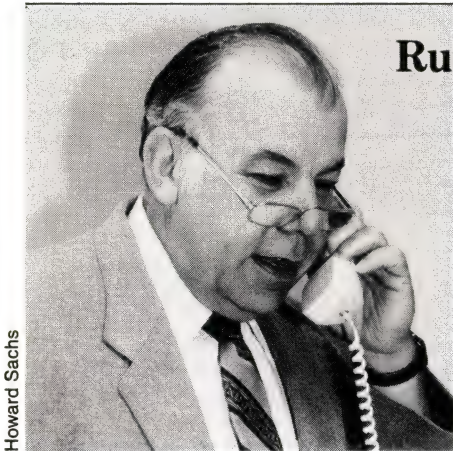
employers. He would like to see the IEEE step in to assist members as a friend of the court and as mediator between the employee and the employer.

Feerst also is a strident supporter of legislation that would require foreign-born engineering students to return to their home countries after graduation. When foreign-born students remain in the US after graduation and seek work, Feerst asserts, American engineers have fewer job opportunities. Feerst regularly combs trade publications for recruitment advertisements that seek engineers with several years of experience and advanced degrees, yet offer a starting salary of less than \$30,000. The only engineers who respond to such advertisements, he says—and, he adds, the engineers at whom such advertising is targeted—are foreign engineers willing to work for below-market wages in order to remain in the US. Feerst reports such ads to members of Congress and Department of Labor representatives. "We should keep

up relentless pressure on offending employers," he says.

Feerst's most pressing goal, however, is to make the organization more representative of its members. Educators and upper-level managers are overrepresented in the IEEE's leadership, he says; as a result, the organization has drifted away from its original purpose. "The IEEE is constitutionally obliged to support engineers," he says. "[IEEE leaders] are unwilling to do this when it means tangling with employers. I don't advocate going out and picking fights with them; it's wrong to do that. But it's perhaps even more wrong to walk away from the lies that have been hurled—that there is a shortage of engineers, that engineers are washed up at 35."

The process of revitalizing the members of the IEEE, Feerst says, is like regenerative feedback: "Once you can show that the IEEE has done something for the working engineer, then you'll be able to attract back the disenchanted members."



Howard Sachs

Russell Drew: Stepping up services at the local level

"I'd like to see better programs at the local level to cause some engineer who'd rather sit home to show up at his section or chapter meeting."

Having extensive experience working within one of the world's largest organizational structures—the US government—Russell Drew hopes to bring better organization to the IEEE should he win this fall's election for president.

"I would like to strengthen the role of the local sections and chapters," Drew says. "I'd like to work on improved communications." By funneling more money to the local levels of the IEEE, Drew hopes to see better regional newsletters, as well as more interesting local meetings and seminars. He envisions the

development of a speakers bureau that would furnish guest speakers and arrange for technical and business experts to embark on speaking tours of several local chapters.

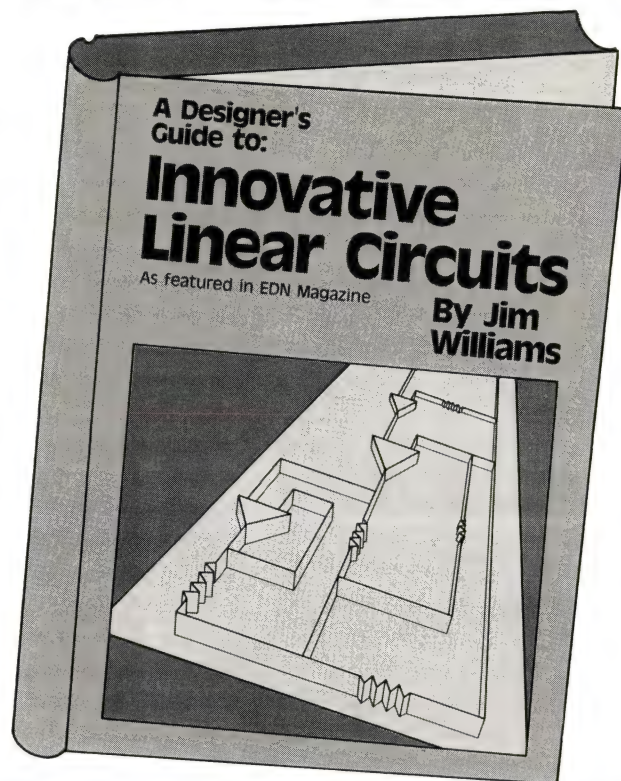
Drew worked in the White House Office of Science and Technology for seven years and then directed the activities of the Office of Naval Research's London facility for one year. Upon returning to Washington, Drew worked for the National Science Foundation on the permanent establishment of the Office of Science and Technology Policy, the White House agency that defines government initiatives in science and engineering.

Drew foresees a time when local sections will be connected by electronic mail. "It's going to cost some money to provide the linkages, the time, and the network," he admits, but he believes it will markedly im-

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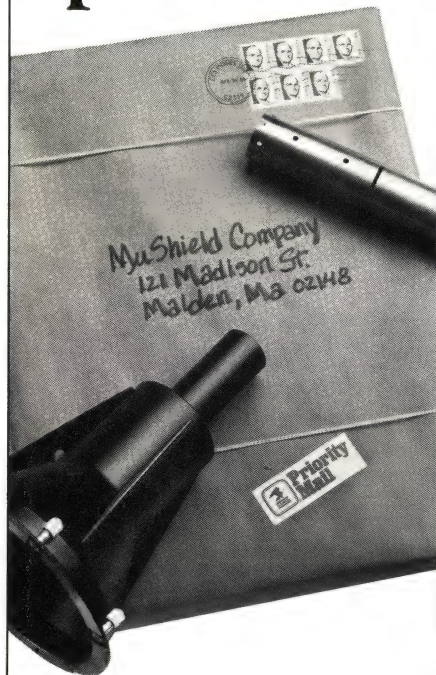
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CIRCLE NO 67

PROFESSIONAL ISSUES

prove communication among local sections. To support improved local service, Drew plans to tap the IEEE's financial reserves. Drawing on the organization's investment income, Drew plans to make a one-time allocation of funds "on the order of \$1 million" to IEEE sections and chapters.

As the IEEE's vice president for professional activities in 1984 and 1985, Drew oversaw the IEEE's committees on career issues, an area that he would try to strengthen as president of the organization. "We need to give some attention to rapid response mechanisms," he says, adding that he wants members to feel comfortable using local section meetings as vehicles for communicating their concerns to IEEE leaders.

Drew targets age discrimination as an area in which the IEEE can do more for its members. "We need to make our members aware of age discrimination and about what constitutes age discrimination. A lot of people don't know what it is and don't understand what their rights and responsibilities are. Education is part of that." To educate members, Drew would support more symposiums on age discrimination such as the April conference the IEEE cosponsored in Washington, DC.

By molding the IEEE's local sections into more receptive and responsive bodies, Drew hopes to energize them. "People participate when they see something at stake or when they see something that's really going to benefit them," he says. "I'd like to see better programs at the local level to cause some engineer who'd rather sit home to show up at his section or chapter meeting. By improving communication and having more vigorous programs and activities, we hope to capture their interest. You have to demonstrate by the quality of the things the IEEE is doing that it's worthwhile for somebody to be active."

Drew's membership in the IEEE began in 1977 when he left government to work for Systems Control, a private company involved in advanced applications of control theory to the management of electrical power systems. Since then, he has served as chairman of the technology policy committee and the productivity and innovation committee. As vice president for professional activities, Drew also served as the sole representative for professional activities on the IEEE's board of directors and was chairman of the board's membership-development committee.

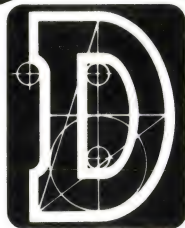
In addition to activating the IEEE's US members, Drew would like to find new ways to give the organization's 60,000 foreign members more of a voice. "I see a great benefit to the membership from the international scope of our organization. I believe that we have not found all of the appropriate ways in which our national membership can participate in the Institute. I'd like to give some attention to ways in which the situation can be improved." Drew suggests that his first step toward examining alternatives would be the formation of a task force.

Drew, who is now president and founder of Viking Instruments, a Sterling, VA, maker of analytical instruments, says that the global good health of the engineering profession reflects positively on American engineering. "Engineering is a very mobile commodity. I believe that by having a strong demand for engineering globally, we in fact reinforce the role of engineering in the US. It keeps us on our toes."

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Oct. 16	Sept. 25	Digital Signal Processing; Personal Computers; ICs; Test & Measurement Instruments; Display Technology	Closing: 10/16 Mailing: 10/28
Oct. 30	Oct. 8	Batteries; Converters; Wescon '86 Product Preview; European Electronics; Computer Boards	
Nov. 13	Oct. 23	Wescon '86 Show Issue; Op Amps; CAE; Semicustom ICs (CAE-related*); Artificial Intelligence (CAE-related*)	Closing: 11/3 Mailing: 11/25
Nov. 27	Nov. 6	Microprocessor Technology Report & Directory; CAE; Passive Components	
Dec. 11	Nov. 18	Product Showcase—Volume I; ICs & Semiconductors; Hardware & Interconnection Devices; Power Supplies/Sources; Software; Literature on Computers & Peripherals, Components, Test & Measurement Instruments, International Products	
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■ **Software Engineers (Senior & Intermediate Levels)**—Requirements include a BSEE with specific ATE experience defining, specifying, designing and developing systems and test application software. Familiarity with HP 1000 Model A 700 operating system, ATLAS, Fortran, Pascal and Ada would be a definite plus; VAX experience desirable.

■ Test Program Set (TPS) Design Engineers—

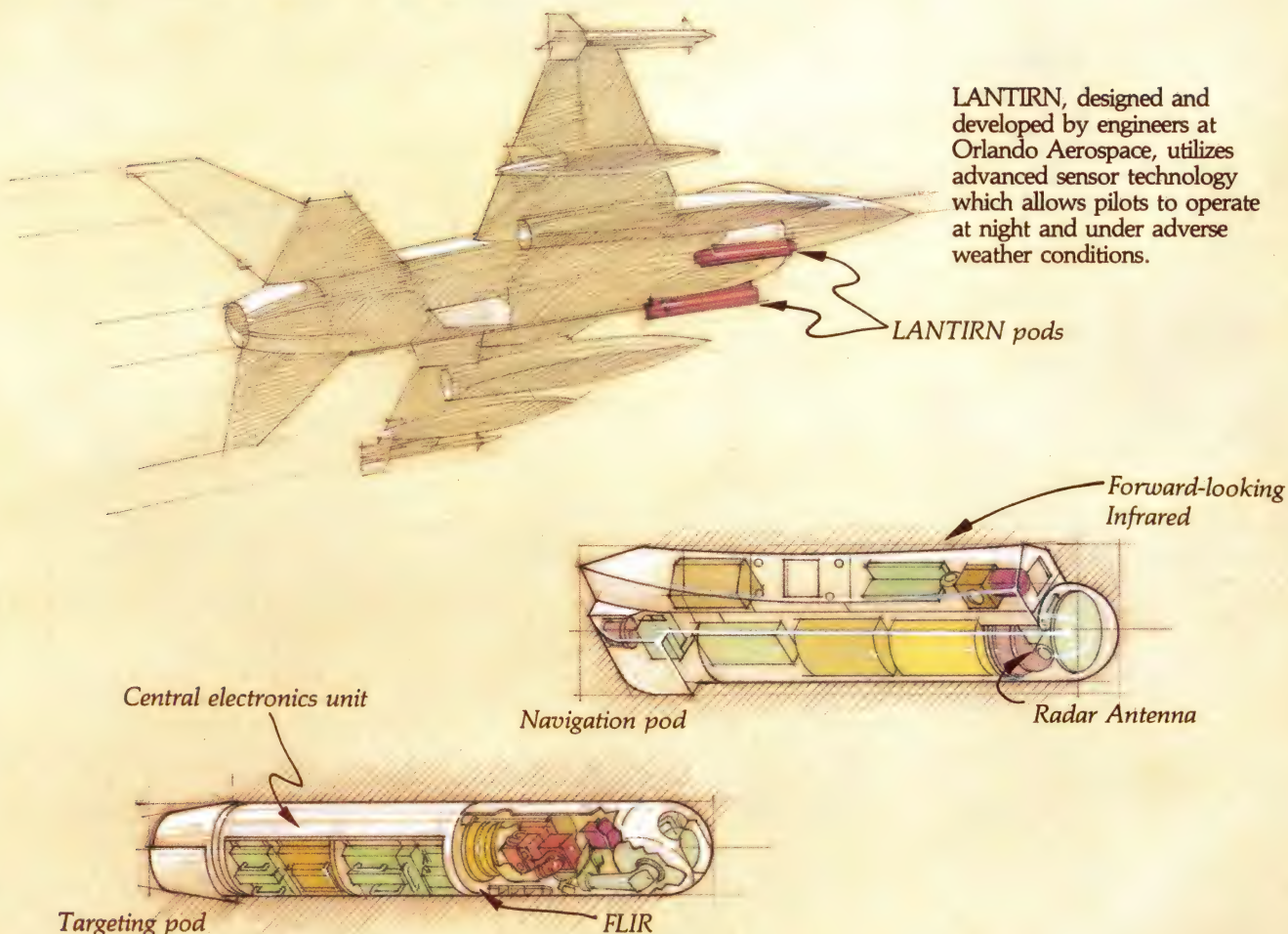
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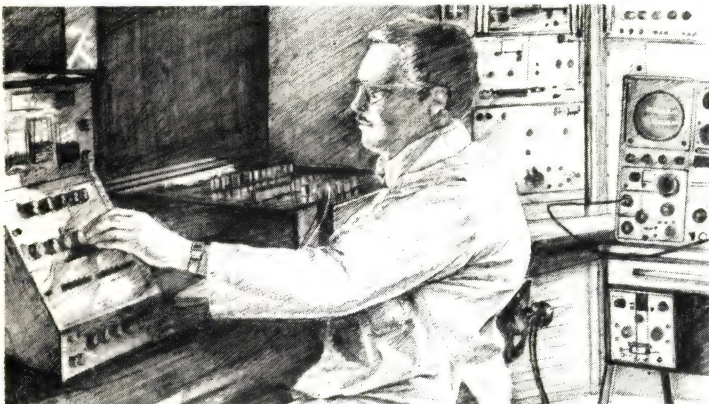
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LOOKING AHEAD

EDITED BY GEORGE STUBBS

μ P technology gives boost to chart recorder sales

The respective market-growth curves for chart recorders that use μ Ps and for those that don't will diverge over the next few years, according to the market-research company Venture Development Corp (Natick, MA). Demand for μ P-based recorders will grow at an 11% annual rate to achieve a \$213 million market by 1991, while demand for traditional recorders that don't employ μ Ps will show a slight decline through the same period. All categories of the μ P-based units will become increasingly popular: strip- and circular-chart recorders, oscillographic systems, and X-Y units.

Shipments of hybrid recorder/loggers—systems that combine the

features of multichannel analog strip-chart recorders and data loggers—should more than double by 1991 to more than \$67 million. Yet the highest annual growth rate for any category of recorders is for the circular-chart variety—35.6%.

The research company believes competition in the field will become more intense over the next few years. Foreign manufacturers, which have benefited from the strong US dollar in recent years, will continue to compete aggressively in US markets. These companies have been able to produce low-cost recorders with attractive additional features. As a result, the value of recorder imports to the US in 1985 was more than twice that of exports by US manufacturers.

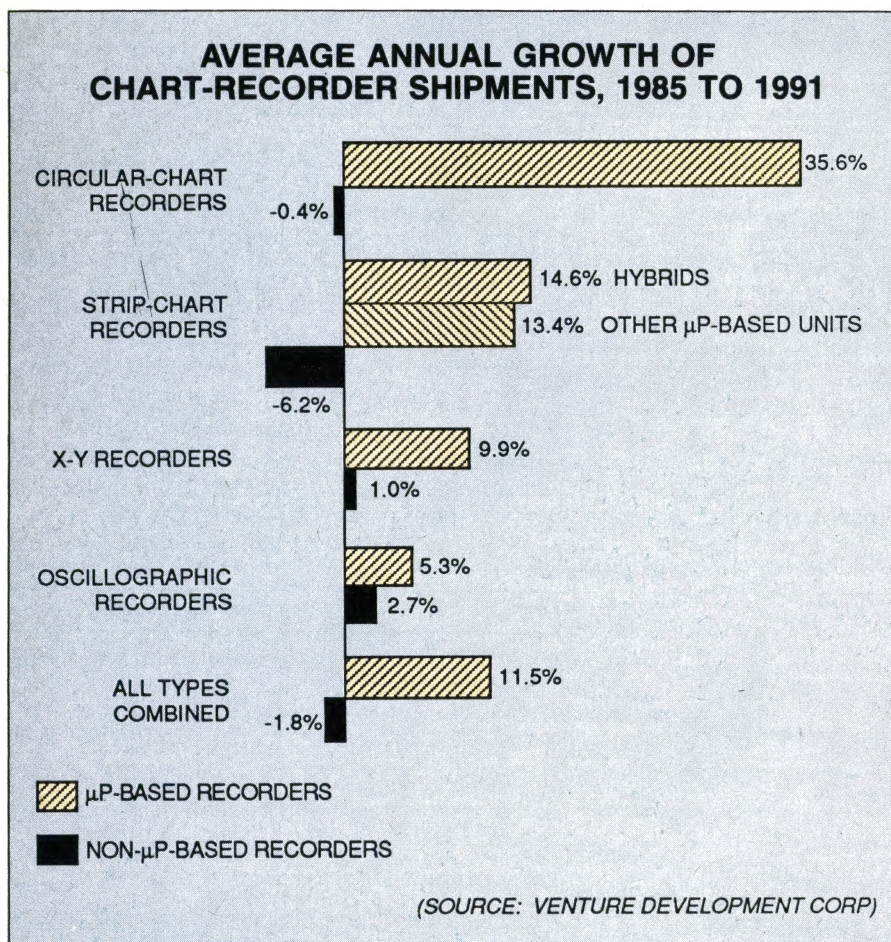
Sales of discrete semis to reach \$9.83B by 1990

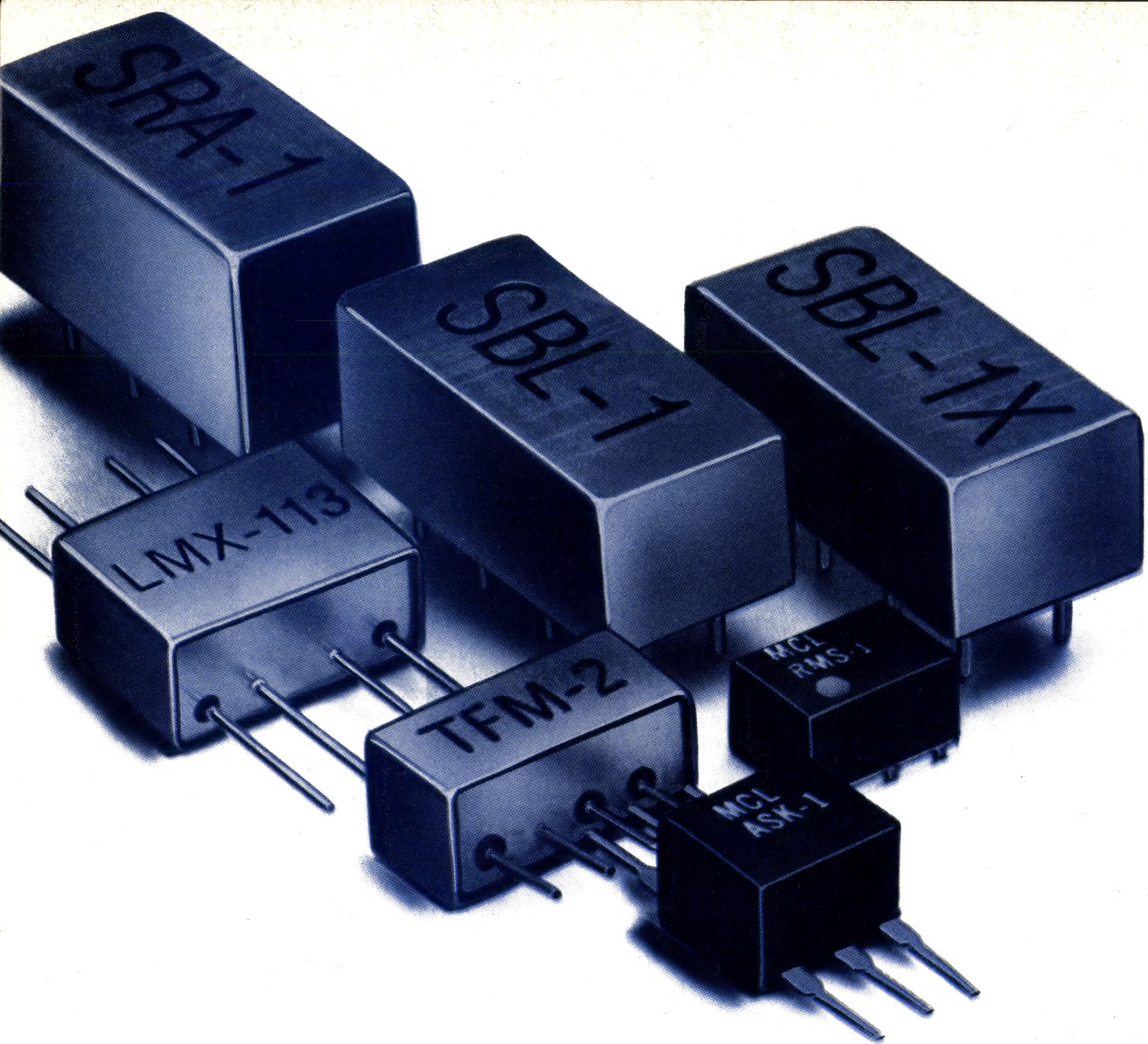
Worldwide consumption of discrete semiconductors, measured in total sales, will rise from 1985's \$5.513 billion to \$9.83 billion by 1990, according to Gnostic Concepts Inc, a market-research concern based in San Mateo, CA. The average annual growth rate through that period will be 12.3%. Customers in the Pacific Basin will sustain that rate with their own considerable use of discrete semiconductors over the next five years, averaging an annual growth of 14.5%.

The largest market for discrete semiconductors in the US is the military and other government departments, which account for approximately 25% of all parts used in this country. Communications equipment makers are the second largest market—estimated 1985 purchases reached \$369 million—but the computer industry should show the strongest growth over the next five years. Gnostic Concepts believes that the industry should see an end to its recent woes in 1987, and that US computer makers will buy \$461 million worth of discrete semiconductors in 1990.

Of all the different types of discrete parts, power MOSFETs will show the strongest rate of growth over the next five years—24% annually, according to Gnostic analyst Barry Haaser. The emergence of new applications, lower prices, and an adequate manufacturing capacity will be the keys to growth in this segment of the industry.

Power ICs are also gaining in popularity (the company defines a power IC as a monolithic device that combines analog or digital functions with a power transistor). Gnostic Concepts projects US OEM consumption of power ICs will reach \$157 million by 1990.





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12 DELETE	22 ILLEGAL BIT CHECK
13 INSERT	23 CHECKSUM
14 COMPLEMENT	24 LIST DEVICE & RAM
15 FILL	25 E-ERASE
16 MOVE	26 E-TEST
17 SEARCH	27 READ SIGNATURE
18 SPLIT	
19 SHUFFLE	
1A CHECKSUM	

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RS-232C

51 TRANSMIT
52 RECEIVE

DEVICE

PROG	VERIFY	READ	TYPE
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UV LAMP

FUNCTION

C	D	E	F
8	9	A	B
4	5	6	7
0	1	2	3

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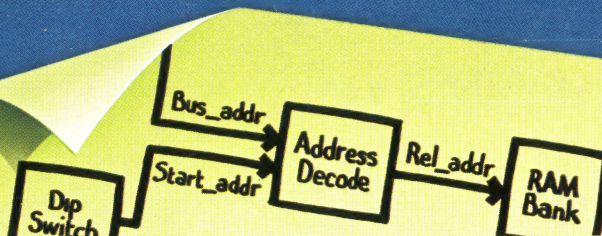
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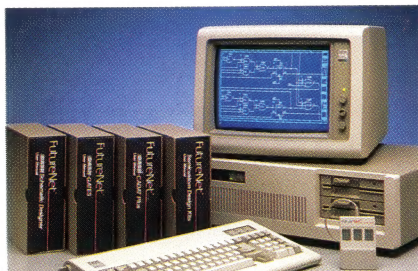
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Data I/O Europe World Trade Center, Strawinskylaan 633, 1077 XX Amsterdam, The Netherlands (20) 622866/Telex 16616 DATIO NL

Data I/O Germany Bahnhofstrasse 3, D-6453 Seligenstadt, Federal Republic of Germany 161821 3088/Telex 4164962 DATA D

Data I/O Japan Sumitomoseimei Highashishinbashi Bldg., 8F, 2-1-7, Highashi-Shinbashi, Minato-ku, Tokyo 105, Japan

(03) 432-6991/Telex 2522685 DATAIO J

FutureNet
A Data I/O Company